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MEMORANDUM:

OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

Subject: Health Effects Division Reregistration Eligibility Decision Chapter for Disulfoton.

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This memorandum and six Appendices constitute the short version of the Health Effects Division Reregistration Eligibility Decision (HED RED) Document for Disulfoton. Consideration is also given to the Food Quality Protection Act of 1996 (FQPA). Attachments include the Toxicology Chapter for the Disulfoton RED (David G Anderson, Appendix 1), the most recent Hazard identification Assessment Review Committee (HIARC) Report for Disulfoton (David G Anderson, Appendix 2), the most recent Dietary Exposure Estimation Model (DEEM ™) Report for Disulfoton (Richard Griffin, Appendix 3), the Product Chemistry and Residue Chemistry Chapters for Disulfoton RED (John Abbots/Ken Dockter, Appendix 4), Occupational/Residential Exposure Chapter (ORE) for Disulfoton RED (Jonathan Becker, Appendix 5) and Memorandum from Jerome Blondell to Jonathan Becker of HED (3/25/1998), Review of Disulfoton Incidence Reports (Jerome Blondell, Appendix 5) and Water Assessment for Disulfoton RED including Drinking Water Assessment and an Draft Drinking Water Assessment for Disulfoton: Water Resources Assessment (James K Wolf, Appendix 6, Part 1 & 2, respectively).

Cumulative risk assessment from other pesticides that have a common mechanism of toxicity will be addressed in the Combined Risk Assessment for all Organophosphates Document.

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(I) EXECUTIVE SUMMARY

The risk assessment shows that disulfoton is a highly hazardous pesticide causing plasma, erythrocyte and brain cholinesterase inhibition at low dose levels. Almost all acute and chronic dietary exposures, occupational and residential exposures are unsatisfactory. The level for dietary concern for all groups occurs when dietary exposure is greater than 100% of the reference dose (RfD). The only dietary consumption that showed less than 100% of the RfD is for chronic dietary exposure for nursing infants <1 year old. The chronic dietary assessment for this group is 80% of the chronic RfD (Table E). Chronic dietary exposures for other groups ranged from 470% to 1381% of the RfD (Table E). Acute dietary exposure ranged from 840% to 1520% of the RfD for the 95% percentile (Table D). The occupational exposure assessment showed that only two types of pesticide handler activities remained with acceptable margins of exposure (MOE) (MOEs were 200 to230) when the assumption was made of base line protection or personal protective equipment (Table H). Occupational exposure is of concern if MOEs are less than 100. With engineering controls, six pesticide handler activities remain with acceptable MOEs (MOE s were 120 to 740) (Table H). Residential exposure assessment showed that only two pesticide handler activities were acceptable (MOEs were 1200 & 1900) (Table I). Residential exposure concern is indicated at less than a MOE of 300. The risk assessment for toddlers (<3 years old), potentially ingesting soil, was satisfactory for vegetable garden application sites, however the residential exposure for the pesticide handler for vegetable gardens was unsatisfactory.

The Drinking Water Level of Concern (DWLOC) is 0.8 μg/L or 8 x10^{-6} mg/kg/day for a nursing infants weighing 10 kg and drinking 1 L of water per day; the only group for which a DWLOC could be calculated. Since all other dietary group assessments were greater than 100% of the RfD, any concentrations of disulfoton in drinking water would be unacceptable.

Tolerances for disulfoton residues were reassessed and ranged from 0.01 ppm for milk to 5.0 ppm for oats and wheat fodder.

An acute delayed neurotoxicity study in hens with a neurotoxic enzyme (NTE) study is required. There are several requirements for product chemistry, tolerance assessments and recommendations for tolerance revocations.

Some minor revisions in the tolerance expression are required for harmonization with Codex. Tolerances that are currently expressed as demeton-S should be expressed as disulfoton.

(1) Background

Three disulfoton manufacturing-use products (MPs) are registered under Shaughnessy No. 032501 to Bayer Corporation: the 98.5% technical (T; EPA Reg. No. 3125-183) and the 68% and 2% formulation intermediates [FIs(Formulation Intermediate); EPA Reg. Nos. 3125-158 and 3125-128, respectively]. We note that REFS identifies the 2% FI as an end-use product; however, the label (dated 6/16/94) states that the product is for repackaging only. This product is correctly identified as an MP. Only the Bayer 98.5%, 68%, and 2% disulfoton MPs are subject to a reregistration eligibility decision.

Disulfoton is an organophosphate insecticide/arachnicide. It is formulated as the 15% granular for use on grains, cotton, sorghum, peanuts, soybeans, tobacco, coffee, non-bearing fruit trees, pecans, vegetables, flowers, shrubs, trees and ground-covers; as the 8% Emulsifiable Systemic for use on grains, grains, cotton, sorghum, tobacco, non-bearing fruit trees, pecans and vegetables; as the 95% Seed Treatment for use on cotton, as the 1%, 2% 5% and 10% Systemic Granules for use on flowers, shrubs, home garden vegetables & greenhouses.

(2) Hazard Characterization

Disulfoton is classified as acutely toxic, toxicity category I, by the oral, dermal and inhalation routes. Disulfoton was too toxic for guideline studies on primary eye, skin irritation and dermal sensitization to be conducted. The data requirements were waived because of the severity of the anticipated results and the most severe categories should be assumed for eye and skin irritation.

The mode of action of disulfoton is inhibition of cholinesterase. In all of the studies evaluated in this hazard assessment, the LOEL and NOEL were established through the inhibition of cholinesterase (the basis for all regulatory endpoints). Clinical signs, such as muscle fasciculation and tremors are seen either at higher dose levels or at the LOEL for some studies. All three cholinesterases (plasma, erythrocyte and brain) are inhibited at the lowest dose tested and are likely to occur across species. There are slight species differences, but the differences may be due to normal variation and differences in the duration of the studies conducted in different species. Adult females appear to be slightly more sensitive than males. In a 6-month study in rats (MRID# 43058401), cholinesterase inhibition was seen only in females.

The cholinesterase endpoints between acute and chronic studies in rats all are within a 10 fold exposure level. Longer exposure always showing cholinesterase inhibition at lower dose levels. Clinical signs occurred at the same dose level as cholinesterase inhibition in the acute neurotoxicity study, whereas in the 90-day neurotoxicity study, cholinesterase inhibition occurred at a lower dose level. Motor activity was affected at lower dose levels in the 90-day study than in the acute study, but no treatment related or significant neuropathology occurred either acutely or in the 90-day studies.

There is no increased susceptibility to fetuses or pups in acceptable developmental and reproductive toxicity studies in the rabbit or rat. Pup death occurred at the highest dose tested. The deaths were attributed to an inadequate milk supply and maternal care failure. In the developmental toxicity study in the rat, developmental toxicity occurred at higher doses than caused toxicity in dams. Developmental toxicity in the rat was seen in the form of incomplete ossification, but no developmental toxicity was seen in the rabbit at the dose levels administered. In the study on reproduction, cholinesterase was inhibited (plasma, erythrocyte and brain) in parents at lower dose levels than in pups.

No obvious endocrine disruption was seen in any of the studies. Absolute testes and ovarian weights were decreased (of unknown cause) at the highest dose levels and in the presence of cholinesterase inhibition in the chronic rat study, which may be endocrine mediated. However, these could not be unequivocally attributed to endocrine effects.

There is an adequate dermal absorption study in rats and an adequate 21-day dermal study in rabbits showing cholinesterase inhibition (plasma, erythrocyte and brain).

There are no carcinogenicity concerns in two acceptable studies in the rat and mouse. An adequate dose level was reached in the study in rats to test the carcinogenic potential of disulfoton, based on decreased body weights and body weight gains. In mice, the highest dose tested in this study is approximates 35% of the LD_{50} and higher dietary concentrations would have resulted in significant compound-related mortality of the test animals. Thus, the dose levels were considered adequate to test the carcinogen potential of disulfoton in mice.

Disulfoton is positive in some mutagenicity studies without activation, but negative or weakly positive in most with activation. With no carcinogenicity concerns and no reproductive toxicity concerns at relevant dose levels, the mutagenicity concerns are low. The mutagenicity data base is complete for the pre-1990 required three mutagenicity categories and the *in vivo* data base support a lack of concern for the mutagenicity of disulfoton.

The metabolism of disulfoton was studied in the rat. It was found to be rapidly absorbed and excreted with over 95% of the administered C^{14} labeled disulfoton being recovered in the urine and

approximately 90% excretion within 24 hours. Less than 2% was recovered from the feces. Bioaccummulation was not observed with less than 0.3% being recovered in tissues and less than 1% being recovered in the carcass. A major metabolite was incompletely identified, but it co-chromatographed with 1-(ethylsulfonyl)-2-(methylsulfonyl)ethane, a fully oxidized form of the putative hydrolysis product. The toxic metabolites of disulfoton are disulfoton sulfoxide, disulfoton sulfone, disulfoton oxygen analog (demeton-S), disulfoton oxygen analog sulfoxide and disulfoton oxygen analog sulfone. The Metabolism Committee determined that the residues to be regulated in plant and animal commodies are disulfoton, disulfoton oxygenated analog and their sulfoxides and sulfones.

(3) Quality of the Toxicity Data Base

The toxicity data base for disulfoton is adequate to support reregistration. The data base is of generally high quality with better than average consistency in data on the dose and treatment relationship of plasma, erythrocyte and brain cholinesterase inhibition which are the regulatory endpoints of concern.

All the toxicity data used to select endpoint for regulation were acceptable guideline studies. The only data gap is an acute delayed neurotoxicity study in hens, guideline §870.6100. The available study was equivocal and determined to be unacceptable and an additional study (870.6100) is required. The latter study guideline also gives guidance for conducting the neurotoxic esterase (NTE) component, which is also required. However, the HIARC indicated that the studies would be considered confirmatory.

(4) Dose Response

All the NOELs and LOELs selected for regulation of disulfoton were based on a dose response relationship with the endpoints selected from the relevant studies. The Health Effect Division (HED) Hazard Identification Assessment Review Committee (HIARC), evaluated the toxicity data base for disulfoton, established an acute Reference Dose (RfD), a chronic RfD and selected endpoints for short term, intermediate term and long term occupational and residential exposure (Table A and B). A dose response relationship or at least a treatment related effect is considered a prime reason for the endpoints selection process by the HIARC.

The HED Food Quality Protection Act (FQPA) Safety Factor Committee evaluated the toxicity data and exposure data and determined that the 10X uncertainty (UF) factor required by FQPA under certain circumstances should be reduced to 3X. The reasons include equivocal results from the acute delayed neurotoxicity study in hens, nominal increases in potential neuropathology in other studies and uncertainties about the need for a developmental neurotoxicity study. FQPA requires an additional 10X UF on food residues and residential exposure unless safety can be assured. Thus, a total UF of 300 is used for food residues and residential exposure in the assessment of disulfoton (10X for intraspecies variation, 10X for interspecies variation and 3X for the above data uncertainties). Table A shows acute and chronic endpoints, RfDs and required MOEs. Table B shows the residential endpoints and required MOE Table C shows the occupational exposure endpoints and required MOEs.

Table A: The doses and toxicological endpoints selected and Margins of Exposure for acute dietary and chronic dietary exposure are summarized in this Table.

Exposure scenario	NOEL [1]	Endpoint	Study	Uncertainty Factor
Acute dietary	0.25 mg/kg/day	Cholinesterase/clinical signs	Acute neurotox/rat (81-8)	300
Acute dietary RfD = 0.00083 mg/kg (FQPA population adjusted dose)				
Chronic dietary	0.013 mg/kg/day	Cholinesterase	Chronic/Dog (83-1)	300
Chronic dietary RfD = 0.000043 mg/kg/day (FQPA population adjusted dose)				

Table B: Endpoints for Residential exposure scenarios and MOEs

Exposure scenario	NOEL 1	Endpoint	Study	MOE required.
Short-term (dermal)	0.4 mg/kg/day	Cholinesterase	21-day dermal/rabbit (82-3)	300
Correction for dermal absorption unnecessary				
Intermediate-term (dermal)	0.03 mg/kg/day [2]	Cholinesterase	6-months oral chronic/rat(NG)	300
Correction for oral to dermal exposure necessary				
Long-term life time (dermal)	0.013 mg/kg/day [2]	Cholinesterase	Chronic oral/dog(83-1)	300
Correction for oral to dermal exposure necessary				
All Time Periods Short-Intermediate and Long-term (inhalation)	0.00016 mg/L [2]	Cholinesterase	90-day inhal/rat(82-4)	300

[1] = No Observed Effect Level.
[2] = Appropriate route-to-route extrapolation should be performed for these risk assessments (i.e., dermal and inhalation exposure components using absorption rates of 36% and 100%. respectively, should be converted to equivalent oral dosages and compared to the oral NOELs).

Table C: The doses and toxicological endpoints selected and Margins of Exposure for Occupational exposure scenarios are summarized in the table below.

Exposure scenario	NOEL	Endpoint	Study	MOE required [1]
Occupational exposure				
Short-term (dermal)	0.4 mg/kg/day	Cholinesterase	21-day dermal/rabbit (82-3)	100 [1]
Correction for dermal absorption unnecessary				
Intermediate-term (dermal)	0.03 mg/kg/day [2]	Cholinesterase	6-months chronic oral/rat(NG)	100 [1]
Correction for oral to dermal exposure necessary				
Long-term life time (dermal)	0.013 mg/kg/day [2]	Cholinesterase	Chronic oral/dog(83-1)	100 [1]
Correction for oral to dermal exposure necessary				
All Time Periods Short- Intermediate and Long-term (inhalation)	0.00016 mg/L [2]	Cholinesterase	90-day inhal/rat(82-4)	100 [1]

[1] = Required margin of exposure for all occupational exposures is 100
[2] = Appropriate route-to-route extrapolation should be performed for these risk assessments (i.e., dermal and inhalation exposure components using absorption rates of 36%and 100%, respectively, should be converted to equivalent oral dosages and compared to the oral NOELs).

(5) Dietary Exposure Estimates from Food Sources

The acute and chronic dietary risk estimates used the Dietary Exposure Estimation Model (DEEM™) software and USDA 1989 -1992 food consumption data.

(1) Acute Dietary Risk: The Tier 1 acute dietary risk was calculated with the aid of DEEM™ using reassessed, tolerance-level residues and 100% crop treated. The acute risk that ranged from eight to 15 times the RfD at the 95% percentile. All infants (<1 year old) were 10 times the RfD and children (1-6 years old) were 15 times the RfD at the 95% percentile. For these risk numbers the 95% percentile is the appropriate percentile to use. The 95%, 99% and 99.9% percentiles are listed in Table D for comparison.

Table D: Summary of acute dietary risk for US population and infants and children as modeled[a] by DEEM™.

	Percentage of the RfD[b]		
Percentile	95%	99%	99.9%
U.S. population all seasons	840%	1388%	2212%
All infants (<1 year old)	958%	1595%	2296%
Children (1-6 years old)	1520%	2177%	2924%

[a] Adjustment factor# 2 not used (Not adjusted for % crop treated or field trial data on potatoes)
[b] Acute RfD = 0.00083 mg/kg/day (FQPA population-adjusted dose)

(2) Chronic Dietary Risk: The Chronic dietary risks using DEEM™ were based on reassessed tolerance-level residues for all commodities (except potatoes and meat and milk) and percent crop treated data from BEAD prepared by Steven Nako (6/18/97). Anticipated residues for potato commodities were based on average field trial data. For livestock commodities, anticipated residues were based on transfer ratios from livestock feeding studies and livestock dietary burdens adjusted for percent crop treated (John Abbotts, 9/17/97). The chronic dietary risk greatly exceeds the Agency's level of concern for the U.S. population and all population subgroups except nursing infants (<1 year old) where risks are 80% of the RfD. Chronic dietary risk estimates were 648% of the RfD for the general U.S. population and 1,382% of the RfD for the most highly exposed subgroup, children 1-6 years old (Table E). Succulent green beans contribute the greatest dietary burden to the chronic risk for the U.S. population (208% of the RfD) and for all infants <1 year (588% of the RfD). The calculated risks are based upon a chronic RfD of 0.000043 mg/kg/day (FQPA population-adjusted dose). The Agency considers an RfD greater than 100% to be a risk concern.

Table E: Summary of chronic dietary risk as modeled by DEEM ™ and based on a RfD = 0.000043 mg/kg/day (FQPA population-adjusted dose).

Population subgroup	Anticipated allowable daily concentration (mg/kg/day)	% of RfD [a]
U.S. population, 48 states, all seasons	0.000278	648 [b]
U.S. population, spring, summer, autumn & winter	0.000262 to 0.000293	610
Region, North East, Mid-West, Southern, Western, Pacific	0.000247 to 0.000297	575
Hispanics, non hispanic whites, non hispanic blacks & other	0.000213 to 0.000306	495
All infants (<1 year)	0.000253	588
Nursing infants (<1 year)	0.000035	80
Non nursing infants (<1 year)	0.000344	801
Children (1-6 years)	0.000594	1382
Children (7-12 years)	0.000374	870
Female (13-19 yrs/not preg. or nursing)	0.000214	498
Female (20+ years/not preg. or nursing)	0.000238	554
Females (13-50 years)	0.000220	512
Females (13+ /pregnant/not nursing)	0.000202	547
Females (13+ /nursing)	0.000274	637
Males (13-19 years)	0.000237	550
Males (20+ years)	0.000222	516
Seniors (55+)	0.000259	602

[a] %RfD = [(dietary exposure)/RfD]X100; [b] Data should be rounded off to one significant figure.

(6) Dietary Exposure from Drinking Water Sources

Potential exposure to disulfoton in drinking water was assessed using modeling and limited monitoring data provided by EFED (James Wolf, 12/15/97).

Surface Water: A Tier 2 assessment was conducted using PRZM3/EXAMS modeling for disulfoton applied to barley, cotton, potatoes, tobacco, and spring wheat at the upper 10th percentile and maximum registered application rates. The maximum peak concentration of parent disulfoton was 117 μg/L and the maximum 60-day average concentration was 94 μg/L .

Ground Water: The Sci-Grow (Screening Concentrating in Ground Water) screening model was used to estimate potential found water concentrations for disulfoton parent. At the maximum application rate, the maximum predicted disulfoton ground water concentration was 0.83 μg/L.

The fate of disulfoton in surface and ground water and the likely concentration cannot be modeled with a high degree of certainty since no data are available for the aerobic and anaerobic aquatic degradation rates and anaerobic soil metabolism. The environmental fate and chemistry data base for disulfoton is incomplete for the parent compound. Fate data are not available for the degradation products. The major routes of dissipation are microbial degradation in an aerobic soil and aqueous photolysis and soil photolysis. The overall results of these mechanisms of dissipation appear to indicate that disulfoton has low to moderate persistence in the environment. Limited data suggested that the degradates are much more persistent.

Monitoring Data: Surface water monitoring data collected by the USGA as part of the National Water Quality Assessment (NAWA) program was also considered (Table F). Disulfoton residues were found in 10 out of 2700 surface water samples. Maximum concentrations were 0.002 μg/L and 0.007-0.041 μg/L in integrated streams/agricultural wells and urban/agricultural streams, respectively. There were no reported detections in about 2200 ground water samples (wells and aquifers). The USGS data in limited in that there are no data on disulfoton use in the area surveyed. In addition, methods with different limits of detection were used and there is no data on the hydrogeography of the sites monitored. However, since agricultural streams contained the highest level detected, some disulfoton use must have occurred in the area monitored.

Table F. Summary of Detections in USGS NAQWA Study (USGS, 1997[1]).

Water Source	%> 0.01 µg/L	Maximum Concentration (μg/L)
Agricultural Streams	0.2	0.041
Urban Streams	0.0	0.007
Integrated Streams	0.0	0.002
Agricultural Wells	0.0	0.002
Urban Wells	0.0	None
Major Aquifers	0.0	None

[1] USGS, 1997 NAQWA, (URL http://water.wr.usgs.gov/pnsp/gwswl.html, August 1997); Gilliom, R.J., W.M. Alley, and M.E. Gurtz, 1995, Design of the National Water-Quality Assessment Program: Occurrence and Distribution of Water-Quality Conditions, U.S. Geological Survey Circular 1112, 33 p.; USGS. 1997. Pesticides in Surface and Ground Water of the United States: Preliminary Results of the National Water Quality Assessment Program(NAWQA) August 1997. Pesticides National Synthesis Project, National Water-Quality Assessment, U.S. Geological Survey

(7) Occupational/Residential Risk Estimates

Only two exposure scenarios had margins of exposure greater than 100 using baseline data with no personal protective equipment (PPE) or engineering controls (EC) (Table G). These same two exposure scenarios were also the only ones acceptable when personal protective equipment (PPE) was assumed to be used (Table G). These were loading and applying granular disulfoton by tractor-drawn spreader for nut trees. When engineering controls were applied, six activities had MOEs greater than 100 (Table G). These were: (1) loading granulars for aerial application to barley at 1 lb a.i./acre, short term only (MOE is 170), (2) loading granulars for aerial application to potatoes at 4 lb a.i./acre, short-term only (MOE is190), (3) loading granulars for tractor drawn spreader applications to cabbage at 1 lb a.i./acre, short-term and intermediate-term (MOEs are740 & 310), (4) loading granulars for tractor drawn spreader applications to non-bearing fruit trees at 102 lb a.i./acre, short-term and intermediate-term (MOEs are 290 & 120), (5) loading granulars for tractor drawn spreader application to flower/ground cover at 28.6 lb a.i./acre, short-term and intermediate-term (MOEs are 1000 & 440), (6) applying sprays with a groundboom at 0.5 lb a.i./acre to sorghum, short-term only (MOE is130), and (6) applying granulars with a tractor drawn spreader to flowers/groundcover at 28.6 lb. a.i./acre, short-term only (MOE is 120) (Table G). For occupational exposures a MOE of <100 is unacceptable.

The only residential uses that had an acceptable MOE were using a push type spreader for granular disulfoton spreading on flower gardens at 0.0005 lbs. ai per 1000 ft^2 and to ornamental shrubs/small trees, 0.00032 lb. a.i./4 ft shrub. MOEs were 1,900 and 1,200, respectively (Table H). There were no data on exposure through the use of disulfoton spikes or post application exposure when disulfoton was used to treat small trees and shrubs. (Short term residential exposures for inhalation and dermal exposures only were assumed.) The reentry calculations indicated that a person could safely enter the area of application only after 34-35 days for pruning and harvesting of flower gardens (Table I). For residential exposures including toddlers a MOE of less than 300 is unacceptable.

The data for toddlers (3 years old) potentially ingesting soil around residential application sites showed a marginally unsatisfactory MOE of less than 300, MOE was 230 for flower beds and a satisfactory MOE of 612 for vegetable gardens (Table J). However, the MOEs for a residential handler of granulars for vegetable gardens were unsatisfactory MOE of 8.2 for the loading/applying with a push type spreader at the lowest recommended rate and with a spoon, shaker can or measuring scoop, MOE of 0.06. Thus, since treatment of flower gardens treated at the higher rate and vegetable gardens have an unsatisfactory residential MOE and potential soil ingesting toddlers need not be considered if these areas are not treated. No residential exposure was assumed for nursing infants (<1 year old).

The use of disulfoton for residential use in flower beds is unrealistic and impractical since the reentry period is greater than 1 day (reentry period is 24-35 days).

Table G: Occupational handler exposure MOEs for Short-Term (S-T) and Intermediate-Term (I-T) with baseline, PPE and engineering controls (EC) as indicated. Data extracted from the Occupational and Residential Exposure Assessment for Disulfoton (Appendix 5)

Exposure scenario	Crop application rates	Risk mitigation level & acceptable MOE [a]	Data Confidence [b]	Total MOE (S-T) [c]	Total MOE (I-T) [c]
All uses except as indicated below	All rates	Baseline MOE=100	L to H	0.009 to 34	0.002 to 9.5
Nut trees, loading or applying granular with a tractor-spreader	All rates	Baseline MOE=100	L	200 to 230	80 to 84
All except as indicated below	All rates	PPE added MOE=100	L to H	1.4 to 18	0.3 to 3.9
Loading or applying granulars with tractor-spreader		PPE added MOE=100			
Cabbage	1 lb a.i./acre		L	54-55	16-18
Flowers/ground cover	28.6 lb a.i./acre		L	77	22
Nut trees	3 lb a.i./acre		L	NA to NA [d]	210 to 240
All uses except as indicated below		EC added MOE=100		1.6 to 33	0.4 to 11
Mixing/load EC for ground boom application		EC added MOE=100			
Wheat	1 lb a.i./acre		M to H	37	8.3
Sorghum	0.5 lb a.i./acre		M to H	75	17
Loading granulars for aerial application		EC added			
Cotton	2 lb a.i./acre	MOE=100	L	85	36
Barley	1 lb a.i./acre		L	170	72
Loading granulars for tractor-spreader application		EC added MOE=100			
Raspberries	8 lb a.i./acre		H	93	39
Potatoes	4 lb a.i./acre		H	190	78
Cabbage	1 lb a.i./acre		H	740	310
Nut trees	3 lb a.i./acre		H	NA	NA
Non-bearing fruit trees	102 lb a.i./acre		H	290	120
Flowers/ground cover	28.6 lb a.i./acre		H	1000	440
Applying sprays with a helicopter		EC added			
barley	1 lb a.i./acre	MOE=100	L to very L	42	8.8
sorghum	0.5 lb a.i./acre		L to very L	84	18
Applying spays with a ground boom		EC added			
sorghum	0.5 lb a.i./acre	MOE=100	M	130	29
Applying granulars for tractor-spreader		EC added			
Cabbage	1 lb a.i./acre	MOE=100	H	86	29
flowers/ground cover	28.6 lb a.i./acre		H	120	41

[a] = Level of mitigation & acceptable MOE; [b] = Confidence in the exposure data, H=high, M=medium, L=low; [c] = Total short term & intermediate exposure (dermal and inhalation); [d] = NA = Not Applicable

For convenience and summary purposes in Table G, the confidence level was chosen from the dominant exposure data base (dermal or inhalation). The confidence (low, medium or high) level for both dermal and inhalation was considered to be the confidence level of the data that dominated the MOE. The confidence level was considered separately for inhalation and dermal MOEs if neither dominated the MOE, however few exposure scenarios had MOEs for inhalation and dermal exposures approximately equal and fewer demonstrated differences in the confidence levels for the dermal and inhalation data when neither were dominant. (Additional details can be found in Appendix 5, Table 3.)

Table H: Residential handler exposure MOEs for Short-Term (S-T).

Type of Protection	Crop application rate	Risk mitigation level & acceptable MOE [a]	Confidence in exposure data [b]	Total MOE(S-T) [c]
All uses except as indicated		Baseline Acceptable MOE=300	L	0.002 to 99
Loading/ applying granular with a push type spreader		Baseline Acceptable		
Roses	0.0018 lb a.i./bush	MOE=300	L	99
flower gardens	0.1 lb a.i./1000 ft^2)		L	93
Flower gardens	0.005 lb a.i./1000 ft^2)		L	1900
Ornamental shrubs/small trees	0.00032 lb a.i./4 ft shrub		L	1200
Application of insecticidal spikes		Baseline Acceptable MOE=300		NA

[a] = Level of protection and acceptable MOE; [b] = Confidence in the exposure data, H=high, M=medium, L=low; [c] = Total short term exposure (dermal and inhalation); [d] = NA = Not Applicable

Table I: Residential exposure post application

Low growing field crops applied at 4.9 lb a.i./acre						Weeding , pruning flower gardens applied at 13 lb a.i./acre					
DAT [a]	DFR [b]	Non-harvesting		Harvesting		DAT [a]	DFR [b]	Non-harvesting		Harvesting	
		Dermal dose [c]	MOE	Dermal dose [c]	MOE			Dermal dose [c]	MOE	Dermal dose [c]	MOE
0	5.5	0.085	0.4	0.20	0.2	0	15	1.5	0.02	0.15	0.2
18	0.031	0.00048	63	0.0011	27	20	0.046	0.0048	6	0.00048	63
24	0.055	0.000085	350	0:00019	150	26	0.0082	0.00085	35	0.000084	350
27	0.002 3	NA	NA	0.000084	360	34	0.00082	0.000085	350	NA	NA

[a] = DAT= days after treatment. [b] = Initial DFR is application rate x conversion factor (lb a.i./acre = 11.209 $\mu g/cm^2$) x fraction of the initial a.i. retained on foliage. [c] = Dose is in mg/kg/day.

Table J: Residential postapplication risk from incidental soil ingestion of disulfoton for toddlers 3 year old.						
Scenario	Application rate per treatment (AR) (lbs a.i./acre) [a]	SRt (μg/g) [b]	IgR (mg/day)	Body weight (kg)	ADD (mg/kg/day) [c]	MOE [d]
Incidental soil ingestion (Flower beds)	13	20	100	15	0.00013	230
Incidental soil ingestion (Vegetable garden beds)	4.9	7.4	100	15	0.000049	612

a = Application rate for flower and vegetable gardens
b = Soil residue (μg/g) = [AR (lbs ai/acre) x 4.54E+8μg/lb x 2.47E-8 A/cm^2 x 0.67 cm^3/g soil x 0.2/cm]
c = Average daily dose (ADD)(mg/kg/day) = [SRt (μg/g) 8 IgR (mg/day) x g/(l,000,000 μg)]/[body weight (kg)].
d = MOE = NOEL (0.03 mg/kg/day)/ADD. SRt = Soil residue on day "t" (μg/g), assuming average day of re-entry "t" is day 0.
IgR = ingestion of soil (mg/day), assumed to be 100 mg/day.

(8) Aggregate Risk (Food, Water and Residential)

There is a potential for exposure of the general public (adults and children) to residues of disulfoton through its residential use in home ornamental and vegetable gardens and through food and drinking water sources. Dietary exposure through food is the major contributor to the aggregate risk estimates.

Acute Aggregate Risk: Acute aggregate risk estimates exceed HED's level of concern. The Tier 1 (95% percentile) acute dietary risk estimates for all populations from food alone greatly exceeds HED's level of concern. Any level of exposure to disulfoton residues through drinking water would only contribute more to an already unacceptable risk estimate from food. Thus, the drinking water level of comparison (DWLOC) is, in effect, zero. Tier 2 (PRZM/EXAMS) estimates of disulfoton in surface waters from conservative screening models indicate concentrations of around 94 μg/L.

Chronic Aggregate Risk: Chronic dietary risk estimates exceed HED's level of concern for the U.S. population and all population subgroups except nursing infants (<1 year old) where risks are 80% of the RfD. No chronic residential use scenarios were identified for disulfoton. Since there is no contribution to chronic aggregate risk from residential use, aggregate risk estimates include only exposure through food and water. HED has calculated a drinking water level of comparison (DWLOC) for nursing infants (<1 yr) of 0.08 μg/L (Table K). The estimated average concentration of disulfoton is 43 μg/L in surface water (Tier 2 PRZM/EXAMS), 0.83 μg/L in ground water (SCI-GROW). Both ground and surface water model estimates predict levels of disulfoton greater that the DWLOC for nursing infants (<1yr). Limited data are available from the 1997 USGS survey data which indicate a maximum concentration of 0.041 μg/L in agricultural streams. Because the USGS 1997 data have a number of limitations, they cannot be used with reasonable certainty to estimate the contribution to the dietary risk of infants from drinking water sources.

Table K: DWLOC for the nursing infants (<1year)							
Population	PRZM-EXAMS (μg/L)	SCI-GROW (μg/L)	RfD (mg/kg/day)	Chronic Food Exposure (mg/kg/day)	Chronic Residential Exposure (mg/kg/day)	Chronic H_2O Exposure (mg/kg/day)	$DWLOC_{chronic}$ (μg/L)
Nursing Infants (<1 yr)	94	0.83	0.000043	0.000035	0	0.0000080	0.08

Short-term Aggregate Risk: Short-term aggregate risk estimates exceed HED's level of concern. Aggregate risk estimates associated with short-term risks include exposure to average residues of disulfoton in the diet (food and water) and dermal and inhalation exposure (1 to 7 days in duration) through the residential application of disulfoton. The aggregate risk assessment includes exposure to average concentrations of disulfoton residues in the diet from commodities with existing tolerances (from the DEEM™ analysis), and the high-end exposure scenario associated with homeowners applying disulfoton with a push-type spreader. Since average concentrations of disulfoton residues in the diet alone exceed HED's levels of concern, any level of exposure from residential uses would only contribute more to an already unacceptable risk estimate from food.

(9) Tolerance Reassessment

The Residue Chemistry Chapter for the disulfoton RED lists the reassessed tolerances and recommends that some tolerances be revoked. The reassessed tolerances range from 0.01 ppm for milk to 5.0 ppm for oats and wheat green fodder. It was recommended that tolerances be revoked for alfalfa fresh and hay, sugar beets roots and tops, sugar beet pulp, pineapple bran, clover, fresh and hay, pop corn forage, hops, peanut hulls, pineapples and foliage, rice and rice straw, spinach and sugarcane. (See Residue Chemistry Chapter of the Disulfoton RED, page 51, Appendix 4).

(10) Required Data

The only toxicity study required for confirmatory purposes is an acute delayed neurotoxicity study with an NTE study. There are requirements for product chemistry and several for tolerance assessments and recommendations for tolerance revocation (See the Appendix 4: Residue Chemistry Considerations for the Disulfoton RED).

(11) Human Incidence Data)

Human data contained in a memorandum from Jerome Blondell to Jonathan Becker of HED (3/25/1998), Review of Disulfoton Incidence Reports, show that disulfoton was 11th among the 28 pesticides reported (1982-1989)(28 pesticides with the highest reported incidence rates) and had the highest ratio for cases when the pesticide was considered the primary cause of poisoning of field workers per 1000 applications. Disulfoton ranked third on percentage of occupational Poison Control Center cases requiring hospitalization and fourth among these 28 pesticides studied on percentage of occupational cases with life-threatening symptoms. Death (including suicides and possible homicides) confounded by misuse is known to infrequently occur; however, no other permanent disability has been adequately documented. The excessive exposure was up to 1381% of the chronic RfD, 1520% of the Acute RfD and disulfoton handler exposure risks are as low as MOE

= 0.002.

(12) Codex

The Codex MRLs are expressed in terms of the sum of disulfoton, demeton-S, and their sulfoxides and sulfones expressed as disulfoton. Some US tolerance are still expressed in terms of demeton-S. However, since the molecular weight of disulfoton is only 6% lower than demeton-S, the difference is small. Codex MRLs and the U.S. tolerances will be compatible when the U.S. tolerance expression is revised to include disulfoton, its oxygen analog, and their sulfoxides and sulfones, calculated as disulfoton.

(II) APPENDICES

Appendix 1 - Toxicology Chapter for the Disulfoton RED.
(David G Anderson)

Appendix 2 - The Hazard Identification Assessment Review Committee Report for Disulfoton.
(David G Anderson)

Appendix 3 - The Dietary Exposure Estimation Model (DEEM™) Report for Disulfoton
(Richard Griffin)

Appendix 4 - Product Chemistry and Residue Chemistry Chapters for the Disulfoton RED
(John Abbots/Ken Dockter)

Appendix 5 - Occupational/Residential Exposure Chapter for the Disulfoton RED
(Jonathan Becker).

and

Memorandum from Jerome Blondell to Jonathan Becker of HED (3/25/1998), Review of Disulfoton Incidence Reports.
(Jerome Blondell)

Appendix 6 - Water Assessment for the Disulfoton RED, Including a Drinking Water Assessment (Part 1) and an updated Draft Drinking Water Assessment for Disulfoton: Water Resources Assessment (Part 2)
(James K Wolf)

/ OPP #

APPENDIX 1
Toxicology Chapter for the Disulfoton RED
David G Anderson

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

10/28/98
MEMORANDUM:

OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

Subject: Health Effects Division Toxicity Chapter for Disulfoton for Reregistration Eligibility Decision (RED).

DP Barcode: D250600
Rereg Case: 0102

PC Code: 032501
Cas Reg No.: 274-04-4
Caswell File No.: 341

From: David G Anderson, Toxicologist David G Anderson 10/28/98
Reregistration Branch-2
HED (7509C)

To: Betty Shackleford/Phip Poli PM 53
Reregistration Branch-3
SRRD (7507C)

Thru: Alan Nielsen, Branch Senior Scientist Alan Nielsen 10/28/98
Reregistration Branch-2
HED (7509C)

The following is the Toxicity Chapter for the RED for disulfoton.

EXECUTIVE SUMMARY:

Disulfoton is classified as acutely toxic, toxicity category I, by the oral, dermal and inhalation routes. Disulfoton was too toxic for guideline studies on primary eye, skin irritation and dermal sensitization to be conducted, thus the data requirements were waived.

The mode of action of disulfoton is inhibition of cholinesterase. In all of the studies evaluated in this hazard assessment, the LOEL and NOEL were established through the inhibition of cholinesterase (the basis for all regulatory endpoints). Clinical signs, such as muscle fasciculation and tremors are seen either at higher dose levels or at the LOEL for some studies. All three cholinesterases (plasma, erythrocyte and brain) are inhibited at the lowest dose tested and are likely to occur across species. There are slight species differences, but the differences may be due to normal variation and differences in the duration of the studies conducted in different species. Adult

females appear to be slightly more sensitive, and in a 6-month study in rats (MRID# 43058401), cholinesterase inhibition was seen only in females.

The cholinesterase endpoints between acute and chronic studies in rats all are within a 10 fold exposure level. Longer exposure always showing cholinesterase inhibition at lower dose levels. Clinical signs occurred at the same dose level as cholinesterase inhibition in the acute neurotoxicity study, whereas in the 90-day neurotoxicity study, cholinesterase inhibition occurred at a lower dose level. Motor activity was affected at lower dose levels in the 90-day study than in the acute study, but no treatment related or significant neuropathology occurred either acutely or in the 90-day studies.

There is no increased susceptibility to fetuses or pups in acceptable developmental and reproductive toxicity studies in the rabbit or rat. Pup death occurred at the highest dose tested. The deaths were attributed to an inadequate milk supply and maternal care failure. In the developmental toxicity study in the rat, developmental toxicity occurred at higher doses than caused toxicity in dams. Developmental toxicity in the rat was seen in the form of incomplete ossification, but no developmental toxicity was seen in the rabbit at the dose levels administered. In the study on reproduction, cholinesterase was inhibited (plasma, erythrocyte and brain) in parents at lower dose levels than in pups.

No obvious endocrine disruption was seen in any of the studies. Absolute testes and ovarian weights were decreased (of unknown cause) at the highest dose levels and in the presence of cholinesterase inhibition in the chronic rat study, which may be endocrine mediated. However, these could not be unequivocally attributed to endocrine effects.

There is an adequate dermal absorption study in rats and an adequate 21-day dermal study in rabbits showing cholinesterase inhibition (plasma, erythrocyte and brain).

There are no carcinogenicity concerns in two acceptable studies in the rat and mouse. An adequate dose level was reached in the study in rats to test the carcinogenic potential of disulfoton, based on decreased body weights and body weight gains. In mice, the highest dose tested in this study is approximates 35% of the LD_{50} and higher dietary concentrations would have resulted in significant compound-related mortality of the test animals. Thus, the dose levels were considered adequate to test the carcinogen potential of disulfoton in mice.

Disulfoton is positive in some mutagenicity studies without activation, but negative or weakly positive in most with activation. With no carcinogenicity concerns and no reproductive toxicity concerns at relevant dose levels, the mutagenicity concerns are low. The mutagenicity data base is complete for the pre-1990 required three mutagenicity categories and the *in vivo* data base support a lack of concern for the mutagenicity of disulfoton.

The metabolism of disulfoton was studied in the rat. It was found to be rapidly absorbed and excreted with over 95% of the administered C^{14} labeled disulfoton being recovered in the urine and approximately 90% excretion within 24 hours. Less than 2% was recovered from the feces. Bioaccummulation was not observed with less than 0.3% being recovered in tissues and less than 1% being recovered in the carcass. A major metabolite was incompletely identified, but it co-chromatographed with 1-(ethylsulfonyl)-2-(methylsulfonyl)ethane, a fully oxidized form of the putative hydrolysis product. The toxic metabolites of disulfoton are disulfoton sulfoxide,

disulfoton sulfone, disulfoton oxygen analog (demeton-S), disulfoton oxygen analog sulfoxide and disulfoton oxygen analog sulfone. The Metabolism Committee determined that the raw agriculture commodity, meat, diary and poultry product residues to be regulated are disulfoton, disulfoton oxygenated analog and their sulfoxides and sulfones.

THE TOXICTY DATA BASE FOR DISULFOTON:

Acute Toxicity (81-1 to 8)

Disulfoton is acutely toxic (Toxicity category I) with an oral LD50 of 1.9 mg/kg for female rats. The dermal LD50 is 3.6 mg/kg for female rats. Note at the LD50, apparently greater than 50% of dermaly applied disulfoton is absorbed, while at lower concentrations only 36% is absorbed. The data requirements for primary eye irritation, dermal irritation and dermal sensitization were waived because of the acute toxicity of disulfoton.

Acute Toxicity of disulfoton, technical

Guideline No.	Study Type	MRID #(S).	Results	Toxicity Category
81-1	Acute Oral	Acc# 072293,Doc# 003958,p41	LD_{50} = M: 6.2 mg/kg; F:1.9 mg/kg	I
81-2	Acute Dermal	Acc# 07793, Doc# 03958,p71 & 004223,p24	LD_{50} = M: 15.9 mg/kg; F: 3.6 mg/kg	I
81-3	Acute Inhalation	Acc# 258569, Doc# 05789	LC_{50} = M: 0.06 mg/L; F: 0.015 mg/L	I
81-4	Primary Eye Irritation	Data requirement waived. Doc# 03958,p12; 004223,p14		
81-5	Primary Skin Irritation	Data requirement waived. Doc# 03958,p12;004223.p14		
81-6	Dermal Sensitization	Data requirement waived. Doc# 03958,p12		
81-7	Acute Delayed Neurotoxicity	MRID# 00129384 Doc# 012484	Equivocal, study to be repeated	
81-8	Acute Neurotoxicity	42755801	Reversible neurotoxic signs consistent with the cholinesterase inhibition 1.5 mg/kg in females and 5.0 mg/kg in males	

Acute Inhalation Study/Rats (81-3)

CITATION: Anonomus (1978) Acute and 5-Day Inhalation in the rat with disulfoton. Study laboratory: Bayer AG Instit. Study# 7827. Date: 9/27/78.
Accession# 258569. Unpublished.

Executive Summary: Disulfoton, technical (94.4%) was administered to 20 Wistar rats/sex/group at 0, 34, 48, 51, 64, 78 or 96 μg/L for males and 0, 3.4, 5, 7, 10, 13 or 20 μg/L for females for 4 hours in a nose only experiment (MRID No.: Accession# 258569). The NOEL for death was 34 μg/L for males and 3.4 μg/L for females. LC50 for males was 60 μg/L with animals dying at ≥ 48 μg/L. The LC50 for females was 15 μg/L with animals dying at ≥5 μg/L.

In addition, 10 rats/sex were administered disulfoton for 4 hour/day for 5 days by inhalation at 0, 0.5, 1.8 or 9.8 μg/L in a nose only exposure; the following cholinesterase inhibition studies were conducted on 5 rats/sex/group after one of the five 4 hour exposures in the 5 day study. After 1 exposure in males, plasma cholinesterase inhibition (≥17%) occurred at ≥1.8 μg/L and erythrocyte cholinesterase inhibition (≥15%) occurred at 9.8 μg/L. After 1 exposure in females, plasma cholinesterase inhibition (≥40%) occurred at ≥1.8 μg/L and erythrocyte cholinesterase inhibition (≥23%) occurred at ≥9.8 μg/L.

After 3 to 5 exposures in males, plasma cholinesterase inhibition was reduced (≥40%) and erythrocyte cholinesterase inhibition (≥16%) at ≥1.8μg/L. After 3 to 5 exposures in females, plasma cholinesterase inhibition was reduced (≥31%) at ≥0.5 μg/L and erythrocyte cholinesterase inhibition was reduced (≥17%) at ≥1.8 μg/L. No deaths occurred after one 4 hours exposure at 9.8 μg/L in either males or females, however, deaths occurred in females after the 3rd exposure at 9.8 μg/L.

The acute inhalation NOEL/LOEL for males and females are 0.0005/0.0018 mg/L based on increased plasma cholinesterase inhibition and NOEL/LOEL of 0.0018/0.0098 mg/L for males and females based on increased erythrocyte cholinesterase inhibition after 1 exposure.

After 3 to 5 exposures, males showed NOEL/LOEL of 0.0005/0.0018 mg/L based on increased plasma and erythrocyte cholinesterase inhibition. Females showed NOEL/LOEL of <0.0005/0.0005 mg/L based on increased plasma cholinesterase inhibition after 3 to 5 exposures and the NOEL/LOEL are 0.0005/0.0018 mg/L based on increased erythrocyte cholinesterase after 3 to 5 exposures.

The study is acceptable under Guideline 81-3 for acute inhalation in rats.

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Acute Delayed Neurotoxicity in Hens (81-7):

CITATION: Hixson, EJ (1983) Acute Delayed Neurotoxicity Study on Disulfoton. Laboratory: Mobay Chemical Corp., Metcalf, Stilwell, KS. Study number 82-418-01 (Mobay# 82655). March 7, 1983). (MRID# 00129384). Unpublished.

EXECUTIVE SUMMARY: Disulfoton (97.8% pure) was administered by gavage at 30 mg/kg to 20 hens; 0.5 mg/kg of atropine was administered (im) 10 minutes before the disulfoton dose and 12.5 mg/kg of PAM-2 was administered (im) 30 minutes after the disulfoton dose (MRID# 00129384). This dosing regimen was repeated at day 22. Five hens were used as a negative control. Five hens were administered atropine and PAM-2 (but no disulfoton) similarly to the disulfoton dosed group as an atropine and PAM-2 control and 10 hens were dosed with tri-O-cresol phosphate (500 mg/kg) as a positive control group. The 30 mg/kg dose level was shown to be lethal to hens without atropine administration. Samples of sciatic nerve, spinal cord (cervical, thoracic and lumbar) and brain (mid-brain, brain stem and cerebellum) were fixed in formalin and histological examination conducted.

The tri-O-cresol phosphate positive control group exhibited typical delayed neurotoxicity.

Pharmacologic signs were observed (loss of equilibrium, decreased activity, diarrhea and locomotor ataxia) in 14/20 hens after the first treatment, which subsided by day 5, except in one hen demonstrating ataxia and torticollis which decreased by day 15. These signs were considered by the report authors to be due to acute effects of disulfoton and not due to delayed neurotoxicity.

Body weight of the disulfoton group (91% of the negative control and 94% of the atropine and PAM-2 treated control) and atropine and PAM-2 groups (97% of control) were lower than control hens at termination.

Neuropathy in the form of degeneration digestion chambers (18/20 disulfoton treated hens versus 9/10 combined control hens), all grade 1 except one grade 2 pathology was seen at the thoracic level in a control hen, neuronal degeneration all grade 1 in (5/20 disulfoton hens versus 1/10 combined control hens, all grade 1) and axonal swelling all grade 1 (6/20 disulfoton hens versus 5/10 combined control hens) and demyelination all grade 1 (0/20 disulfoton treated hens versus 1/10 combined control hens). Macrophage accumulation occurred in 17/20 (85%) disulfoton treated hens versus 7/10 (70%) combined control hens. Macrophage accumulation an/or lymphocyte accumulation occurred in 4/5 of the disulfoton treated hens and in 1/10 of the combined control hens with neuronal degeneration. However, this accumulation was not always noted at the same site as the neuronal degeneration. This inflammation in old hens adds uncertainty to the effects seen in the study. **The study is suggestive but equivocal for delayed neurotoxic effects.**

The study is down graded from acceptable to unacceptable and not upgradable for an acute delayed neurotoxicity study in hens (81-7). Due to the equivocal but suggestive nature of the neurotoxic effects and the use of older hens. The study should be repeated using 8-14 month old hens. SignOff Date: 2/12/1998; DP Barcode: D241669; HED DOC Number: 012484.

The HAZARD ID SARC for disulfoton recommended that a DCI be issued for an Acute

Delayed Neurotoxicity in hens (81-7) with an added NTE study with disulfoton. These new studies are requested because 17 month old hens instead of 8 to 14 month old hens were used and neuronal degeneration (5/20 versus 1/10 in controls, all grade 1) was seen, which were considered suggestive but equivocal (because of the age of the hens) for neuronal effects. Depending on the results from these new studies, additional studies may be required.

Subsequent to a HAZARD ID SARC meeting on disulfoton, a neurotoxicology subgroup of the HAZARD ID SARC reviewed the original acute delayed neurotoxicity study in hens (MRID# 00129384) with disulfoton. They considered the study data was suggestive of organophosphate induced delayed neuropathy (OPIDN) and recommended that another study should be conducted. The FQPA Safety Factor Committee reduced the 10X UF to 3 due to the suggestive nature of OPIDN and until a fully acceptable and negative Acute Delayed Neurotoxicity study in hens with NTE study are submitted and evaluated. The DER (TOX# 004698) for the study, which had classified the study as acceptable, had raised questions about its acceptability in the HAZARD ID SARC meeting. A new Executive Summary has been prepared indicating that the hen study has been reclassified from acceptable to unacceptable not upgradable.

Acute Neurotoxicity/Rat (81-8)

Executive Summary: In an acute neurotoxicity screening study, disulfoton (97.8% pure) was administered in a single gavage dose to 10 male Sprague-Dawley rats at doses of 0, 0.25, 1.5, or 5.0 mg/kg and to 10 female Sprague-Dawley rats at doses of 0, 0.25, 0.75 or 1.5 mg/kg (MRID# 42755801). These rats were assessed for reactions in functional observational battery (FOB) and motor activity measurements at approximately 90 minutes post-dosing and on days 7 and 14. Cholinesterase determinations (erythrocyte and plasma) were made at 24 hours post-dosing. Six rats/sex/dose were examined for neuropathological lesions.

At 0.75 mg/kg, 4/10 females had muscle fasciculations. At 1.5 mg/kg, males had muscle fasciculations, diarrhea, and sluggishness and females also had tremors, ataxia, oral staining, decreased activity/sluggishness, decreases in motor and locomotor activity (38–49% of control), and a slightly increased duration of nasal staining. One female at 1.5 mg/kg died from cholinergic intoxication on the day of dosing. At 5.0 mg/kg, males also had symptoms similar to those observed in females at 1.5 mg/kg/day, including reduced motor/locomotor activity (36–45% of control). Recovery appeared to be complete in surviving animals by Day 14. **Based on the evidence of neurotoxicity (probably associated with inhibition of cholinesterase) in females at 0.75 mg/kg, the study LOEL is 0.75 mg/kg and the study NOEL is 0.25 mg/kg.**

At 0.75 mg/kg in females, cholinesterase activities were inhibited by 53% (erythrocyte) and 30% (plasma) and by 75% (erythrocyte) and 52% (plasma) at 1.5 mg/kg in females. At 5.0 mg/kg in males, cholinesterase activities were inhibited by 21% (erythrocyte) and 25% (plasma). **The LOEL for inhibition of cholinesterase activity is 0.75 mg/kg and the NOEL for inhibition of cholinesterase activity is 0.25 mg/kg.**

This study is classified as core-minimum and satisfies the guideline requirement for an acute

neurotoxicity screen (81-8).

Subchronic Inhalation/Rats (82-4)

CITATION: Shiotsuka, RN (1989) Subchronic inhalation study of technical grade disulfoton (Di-Syston®) inhalation in rats. Testing Lab: Mobay Corp. Study# 88-141-AU/99648. Date: 7/31/89. MRID# 41224301. Unpublished study.

Executive Summary: Disulfoton was administered by inhalation to 12 Fisher 344 rats per sex per group for air control, polyethylene glycol-400: 50% ethanol vehicle control, 0.015, 0.15 or 1.5 mg/m^3 nominal dose levels for 90-days in a nose only chamber (MRID No.: 41224301). The analytical determined mean dose levels were 0, 0, 0.018, 0.16 and 1.4 mg/m^3 for male and female rats. The rats were exposed to the test material 6 hours per day, 5 days per week. The particle sizes in the inhalation chambers had a MMAD ± geometric standard deviation of 1.3 ± 1.4, 1.1 ± 1.3, 1.0 ± 1.3 and 1.1 ± 1.4 μm for the two controls, 0.015, 0.15 and 1.5 mg/m^3 nominal dose levels, respectively. The range in mean daily particle sizes had a MMAD of 0.5 ± 1.0 μm to 2.6 ± 1.6 μm.

At the highest dose level, plasma cholinesterase was depressed in males (19% and 14% from air controls at 38 days and term, respectively, $p \leq 0.05$) and in females (27% and 31% from air controls at 38 days and term, respectively, $p \leq 0.05$). Brain cholinesterase was depressed in males (29%) and females (28%) at termination. Erythrocyte cholinesterase was depressed in females at 38 days (11% at 38 days, $p \leq 0.05$, not considered biologically relevant) at 0.16 mg/m^3 and higher in males and females at 1.4 mg/m^3 at 38 days and term. Brain cholinesterase were depressed (10%, $p \leq 0.05$) at 0.16 mg/m^3, but this degree of variation was not considered biologically relevant due to variation noted in this parameter. Inflammation of the male nasal turbinates occurred at 1.4 mg/m^3. No other test material related effects were noted. **The NOEL/LEL is 0.16 mg/m^3/1.4 mg/m^3 or 0.00016/0.0014 mg/L for plasma, erythrocyte and brain cholinesterase depression.**

Core classification: Guideline. The study (MRID# 41224301) is acceptable under guideline 82-4 for a 90-day inhalation study in rats.

Comments about study and/or endpoint: This study also has cholinesterase inhibition data for day 37.

21-Day Dermal Toxicity/Rabbits (82-5)

CITATION: Flucke, W. (1986) Study of Subacute Dermal Toxicity to Rabbits. Bayer AG, Fachbereich Toxikologie, Wuppertal - Elberfeld, F.R. Germany. Study No.:14747. June 20, 1986. MRID 00162338. Unpublished.

EXECUTIVE SUMMARY: In a repeated dose dermal toxicity study (MRID 00162338) S276 Technical disulfoton (97.8% a.i., Batch No. 79-R-225-40), was applied to the shaved skin of 5 New

Zealand White rabbits/sex/dose at dose levels of 0, 0.4, 1.6 or 6.5 mg/kg, 6 hours a day, 5 days/week for 15 days. Doses were selected based on a preliminary range-finding study in which clinical signs of cholinergic intoxication and death at 10 mg/kg/day following 1 or 2 applications. Slight inhibition of plasma ChE inhibition at 2 mg/kg and no effect on plasma or RBC ChE inhibition at 0.4 mg/kg. Plasma and RBC ChE were determined at study initiation, day 6, 11, and termination. Brain ChE was determined at termination.

Repeated dermal application of disulfoton or vehicle (Cremophor EL in sterile saline) 6 hours a day for 15 days had no effect on hematology, clinical chemistry, urinalysis, gross pathology and absolute and relative organ weights. There was no dermal reaction to repeated dermal application. **Systemic Toxicity** was observed in high-dose males and females as a marked reduction in food consumption and body weights and death ensuing within 1 to 2 weeks of initiation of treatment. The **Systemic Toxicity NOEL = 1.6 mg/kg/day** and **LOEL = 6.5 mg/kg/day**, based on reduced food consumption and weight gain.

At the highest dose, all males and females died or were sacrificed following ≈ 6 days of treatment due to acute cholinergic signs such as muscle spasms, dyspnea and salivation. In one high dose male which survived 6 treatments, plasma (75%) and RBC (31%) Cholinesterase was depressed. Plasma ChE of mid-dose males (17 - 24%) and females (31 - 44%) depressed; RBC ChE of males (15 - 19%) and females (7 - 33%) was depressed, compared to concurrent controls. Brain ChE of males and females was depressed 7 - 8%. The ChE **NOEL = 0.4 mg/kg/day and LOEL = 1.6 mg/kg/day**, based on inhibition of plasma and RBC ChE and marginal inhibition of brain ChE.

The study is classified as **Acceptable** and satisfies the guideline requirement for a subchronic dermal toxicity study (82-2) in rabbits.

Subchronic Neurotoxicity Study/Rats (82-7)

CITATION: L.P. Sheets and B.F. Hamilton (1993) A subchronic dietary neurotoxicity screening study with technical grade disulfoton (Di-Syston®) in Fischer 344 rats. Testing lab.: Miles Inc. Study# 92-472-NS (106332). Date: 9/23/1993. MRID# 42977401. Unpublished study.

EXECUTIVE SUMMARY: In a subchronic neurotoxicity study (MRID# 42977401), disulfoton (98.7–99.0% pure) was administered in the diet to 12 male and 12 female Fischer 344 rats at dietary levels of 0, 1, 4, or 16 ppm (0, 0.063, 0.270, and 1.08 mg/kg/day in males and 0, 0.071, 0.315, and 1.31 mg/kg/day in females). Of these 12 rats/sex/dose, 6/sex/dose were used for a neurohistopathological examination at the end of the study.

At 4 ppm, females had muscle fasciculations, urine staining, and increased food consumption (approximately 110% of control). At 16 ppm, both males and females had increased reactivity, perianal staining, tremors, increased defecation, decreased forelimb grip strength (37–86% of control), decreased motor and locomotor activity (39–71% of control), decreased body

weight gain (81–83% of control), and corneal opacities. At 16 ppm, males also had muscle fasciculations and appeared sluggish, and one female died due to cholinergic intoxication. **The study LOEL is 4 ppm (0.315 mg/kg/day) and the study NOEL is 1 ppm (0.071 mg/kg/day), based on clinical signs in females consistent with neurotoxicologic effects of cholinesterase inhibition.**

Erythrocyte, plasma, and brain cholinesterase activities were inhibited by 15–23%, 59–80%, and 87–100% in females at 1, 4, and 16 ppm, respectively, and 20–67% and 66–100% in males at 4 and 16 ppm, respectively. Males at 1 ppm had a statistically significant inhibition of erythrocyte cholinesterase at 13 weeks (15% inhibition); other cholinesterase activities in males at 1 ppm were not significantly affected. **The LOEL for inhibition of cholinesterase activity is 1 ppm and the NOEL for inhibition of cholinesterase activity is less than 1 ppm.**

This study is classified as core-guideline and satisfies the guideline requirement for a subchronic neurotoxicity screen (82-7).

Chronic Toxicity Studies/Dogs (83-1b)

CITATION: Jones, R.D. and T.F. Hastings (1997) Technical grade Disulfoton: A chronic toxicity feeding study in the Beagle dog. Bayer Corporation, Stillwell, KS. Study Number 94-276-XZ. Report No. 107499. February 5, 1997. MRID 44248002. Unpublished.

EXECUTIVE SUMMARY: In a chronic toxicity study (MRID 44248002), disulfoton (97% a.i.%) was administered orally in the diet to purebred beagle dogs (4/sex/dose) at dose levels of 0.5, 4 or 12 ppm (equivalent to 0.015, 0.121 and 0.321 mg/kg/day for males; and 0.013, 0.094 and 0.283 mg/kg/day for females) for one year. Potential ocular and neurologic effects were addressed.

Plasma cholinesterase was decreased starting at day 7 in the 4.0 ppm dose groups of the study through to termination (males 39% to 46%; females 32% to 45%). Erythrocyte cholinesterase was decreased starting at day 91 in the 4.0 ppm dose groups through to termination (males 23% to 48%; females 17% to 49%). Not all the values at 4.0 ppm were statistically significant, probably because of the wide range in values, but at least 2 animals per group showed biologically significant cholinesterase inhibition.

By termination cholinergic effects of the plasma, erythrocytes, brain, and ocular tissues were observed in both sexes in the 4 and 12 ppm treatment groups. Plasma and erythrocyte cholinesterase depression are compared to pretreatment values. Brain, cornea, retina and ciliary body cholinesterase depression are compared with concurrent control values at termination only. In the 12 ppm treatment groups, depressed cholinesterase was observed in plasma (56%-63%), erythrocytes (30%-91%), and brain (32%-33%) compared to their respective controls. In the 4 ppm treatment groups in males and females, cholinesterase was depressed in plasma (38%-46%), erythrocytes (40%- 38%), and brain (females only, 22%). Disulfoton inhibited cholinesterase of the

cornea, retina, and ciliary body, but did not appear to alter the physiologic function of the visual system. In the 12 ppm treatment groups, depressed cholinesterase was observed in the cornea (60-67%), ciliary body (45-54%), and retina (males only; 67%). In the 4 ppm treatment groups, cholinesterase was inhibited in the cornea (50-60% lower), and retina (females only, 25%). No treatment-related ophthalmology findings or histological or electrophysiological changes in the retina were observed. No other treatment-related effects were observed. No animals died during the study. No treatment-related effects were observed in sytemic toxicity including food consumption, body weights, clinical signs, hematology, clinical blood chemistry or urinalysis parameters, electroretinograms, electrocardiogram or clinical neurological findings, organ weights or gross or microscopic post-mortem changes in any treatment group. No neoplastic tissue was observed in dogs in the treatment and control groups. **The LOEL is 4 ppm (0.094 mg/kg/day), based on depressed plasma, erythrocyte, and corneal cholinesterase levels in both sexes, and depressed brain and retinal cholinesterase levels in females. The NOEL is 0.5 ppm (0.013 mg/kg/day). These LOEL/NOEL for plasma cholinesterase inhibition extend from day 7 to termination and for erythrocyte cholinesterase inhibition they extend from day 91 to termination.**

This study is classified **acceptable** and satisfies the Subdivision F guideline requirement for a chronic oral study in non-rodents (83-1b).

Chronic Toxicity Study/Dogs (83-1b)

CITATION: Hoffman, K.; Weischer, C.H.; Lucháus, G.; et al. (1975) S 276 (Disulfoton) Chronic Toxicity Study in Dogs (Two-year Feeding Experiment). Bayer, AG, W. Germany. Report No. 45287. December 15, 1976. MRID 00073348. Unpublished.

EXECUTIVE SUMMARY: In a chronic feeding study (MRID 00073348) Technical Di-Syston (95.7% a.i.) was administered in diet to 4 Beagles/sex/dose in the diet at dose levels of 0, 0.5, 1 or 2/5/8 ppm (0, 0.0125, 0.025 or 0.05/0.125/0.2 mg/kg/day, converted) for 104 weeks. In the high-dose group, 2 ppm was given for first 69 weeks, 5 ppm from 70 - 72 weeks, and 8 ppm from week 73 - termination. Body weights were determined weekly for 52 weeks, then biweekly until termination. Clinical evaluations to detect cholinergic signs, ophthalmological evaluations, hematology, clinical chemistries, urinalysis were performed on all animals pre-treatment, on weeks 13, 26, 39, 52, 65, 78, 91, and at termination. Plasma, and RBC cholinesterase was determined at 2-week intervals during the first 13 weeks and at about 3 month intervals thereafter. Brain cholinesterase was determined immediately after necropsy.

Treatment had no effects on general appearance and behavior, and toxic signs, ophthalmoscopy examinations, food consumption, body weight, hematology, clinical chemistry, organ weight and/or histopathology. At 2 ppm, plasma and RBC cholinesterase (ChE) was inhibited 50 and 33% in males and 22 and 36% in females, respectively, during week 40. Large fluctuations in plasma and RBC ChE inhibitions occurred until the dose was raised to 8 ppm. By the termination

(104 weeks) of study, the plasma, RBC and brain ChE was inhibited 65, 58, and 34% in males and 49, 48 and 18% in females, respectively, compared to pre-treatment values. Based on the above, the **Systemic Toxicity NOEL = 2 ppm** (0.05 mg/kg/day) and **LOEL > 2 ppm**. The **cholinesterase NOEL = 1 ppm** (0.025 mg/kg/day) and **LOEL = 2 ppm** (0.05 mg/kg/day), based on plasma and RBC ChE inhibition.

The study is classified as **Acceptable** and **satisfies** the guideline requirement for a chronic toxicity study (83-1b) in the dog.

Carcinogenicity/Mice (83-2b)

CITATION: Hayes, R.H (1983) Oncogenicity study of disulfoton technical on mice. Corporate Toxicology Department, Mobay Chemical Corporation, Stilwell, KS. Study No. 80-271-04. August 10, 1983. MRID 00129456. Unpublished study.

EXECUTIVE SUMMARY: In a carcinogenicity toxicity study (MRID 00129456 & 00139598), disulfoton (98.2% a.i.) was administered to 50 Crl:CD-1 mice/sex/dose in the diet at dose levels of 0, 1, 4, or 16 ppm (0.15, 0.6, or 2.4 mg/kg/day, converted) for 108 weeks. In addition, 10 mice/sex/group were used as replacement animals. Cholinesterase activity in the plasma, RBC, and brain was determined at final sacrifice for 10 mice/sex randomly selected from the control and 16 ppm groups.

Treatment had no effect on bodyweights, food consumption, hematology, and mortality. Eight mice i.e., 1 male and 3 females from the 1 ppm group, 3 males from the 4 ppm group, and one male from the 16 ppm group, died during the first month and were replaced. Survival at 18 months ranged from 76 - 86% in all males, and 68 - 82% in all females. At termination survival ranged from 56 - 66% and 38 - 54%, in males and females, respectively. Cholinesterase (ChE) was markedly inhibited at the high-dose. In males, the plasma, RBC and brain ChE was inhibited 79, 56, and 44%; and in females it was inhibited 82, 50, and 46%, respectively, compared to controls. Enlarged spleen, liver, and lymph nodes were observed with greater frequency in females than males,; histologically diagnosed as lymphomas. The number of animals with malignant lymphoma, of all histologic cell types, were 10, 9, 12, and 15 in males and 27, 22, 26, and 34 in females, at 0, 1, 4, and 16 ppm, respectively. Tumor incidence lacked statistical significance by either the Chi-square or Fisher exact test. In high-dose females, absolute and relative kidney weights increased 22% and 11%, respectively, probably related to increased incidence of lymphomas in this organ. None of the increased organ weights/histopathological findings were considered treatment-related.

Based the above findings, the **Systemic Toxicity NOEL < 2.4 mg/kg/day and LOEL = 2.4 mg/kg/day**, based on plasma, RBC and brain ChE inhibition in males and females.

At the doses tested, there was not a treatment related increase in tumor incidence when compared to controls. Dosing was considered adequate for testing the carcinogenic potential of disulfoton, even though, there was no clear indications of systemic toxicity such as body weight

gains and liver specific enzymes. The highest dose tested in this study is approximates 35% of the LD_{50} and higher dietary concentrations would have resulted in significant compound-related mortality of the test animals.

The study is classified as **Acceptable**, and satisfies the guideline requirement for a oncogenicity study (83-2b) in mice.

Chronic feeding/Oncogenicity Study/Rats (83-5)

CITATION : Hayes, R.H (1985) Chronic feeding/oncogenicity study of technical disulfoton (Di-SYSTON) with rats. Mobay Chemical Corporation, Stilwell, KS. Study No. 82-271-01. June 25, 1985. MRID #s 00146873. Unpublished.

and

Supplementary data upgrading MRID# 00146873 from supplementary to acceptable on the Harderian gland (MRID# 41850001) and optical and optic nerve lesions (MRID# 41850002).

EXECUTIVE SUMMARY: In a chronic feeding/carcinogenicity study (MRID # 00146873, 41850001, 41850002) Disulfoton (98.1% a.i., Batch No. 79-R-255-40) was administered to 60 Fischer 344 rats/sex/dose in the diet at dose levels of 0, 0.8, 3.3, or 13 ppm (0, 0.04, 0.165, or 0.650 mg/kg/day, converted by std. tables) for 105 weeks. Hematological determinations were done on 20/sex/dose and urine and blood chemistry on 10/sex/dose, randomly selected, at 0, 3, 6, 12, 18, and 24 months. Plasma and red cell cholinesterase (ChE) was determined on 10 rats/sex/dose at pre-treatment, 4, 14, 27, 53, 79 and 105 weeks and brain ChE at termination.

Administration of disulfoton in the diet up to 13 ppm had no effect on mortality, hematology, clinical chemistry and urine analysis. Mean body weights of high-dose rats were significantly depressed throughout the study. Body weight gains of high-dose males and females were depressed 29% and 48%, respectively, by termination when compared to the controls. At the mid and low dose, mean body weights of males were sporadically depressed, however, by the end of study the mean body weights were similar to controls. Females body weights were not effected at these dose levels. At 13 ppm, in females the absolute heart (9%) , liver (17%), and testes (24%) were decreased; in females the heart (13%), kidneys (13%), liver (27%) and ovaries (57%) decreased. Absolute brain weight was unchanged in males and females. In high-dose females the relative brain (59%), heart (33%), and kidneys (34%) increased, compared to the controls. Also, the relative lung (72%) and liver (9%) and brain (58%) weights were increased. At this dose the male relative brain weights were increased by 17%. None of the aforementioned organ weights were associated with any histopathology corroborative of toxicity. In high-dose males Harderian gland degenerative changes increased to 460% of controls and in females the elevation was dose-related (800, 1100 and 1633% of control values, respectively, all $p \leq 0.05$). Since there is no Harderian gland in the humans, the significance of pathological changes seen in the rat are uncertain. In addition, corneal vascularity (693% of control), corneal epithelial hyperplasia (1633% of control) and optic nerve degeneration (145% of control) were elevated in high-dose females and corneal vascularity

(329% of control) in males. The eye histopathology was not affected in the mid and low doses. Based on the above, the **Systemic Toxicity NOEL = 0.8 ppm (0.04 mg/kg/day) and LOEL = 3.3 ppm (0.165 mg/kg/day)**, based on Harderian gland degeneration.

At termination, a dose-related inhibition in plasma, red cell and brain ChE was observed at all doses in both sexes. In males the plasma, red cell and brain ChE was inhibited 11%-94%, 19%-80%, and 16%-79%; and in females, it was 25%-95%, 12%-76%, and 21%-82%, respectively, compared to the controls. The **Cholinesterase NOEL < 0.8 ppm (0.04 mg/kg/day) and LOEL = 0.8 ppm (0.04 mg/kg/day)**, based on plasma, red cell and brain ChE inhibition in males and females. Starting at week 4 the LOEL in plasma ChE inhibition was 4 ppm (0.165 mg/kg/day) in males (27%) and females (64%) with a NOEL of 1 ppm (0.04 mg/kg/day). Starting at week 4 the LOEL in erythrocyte ChE inhibition was increased at 1 ppm (0.04 mg/kg/day) (LDT) in males (16%) and females (30%) with no NOEL.

The maximum tolerated dose (MTD) was reached, based on decreased body weights and body weight gains and is considered adequate to test the carcinogenic potential of Disulfoton. Disulfoton treatment did not alter the spontaneous oncogenicity profile in both males and female Fischer 344 rats under the test conditions. In males and females, leukemia, adrenal cortex adenoma, adrenal pheochromocytoma, pituitary adenoma and carcinoma and thyroid-C cell adenoma was most frequently observed. Mammary gland fibroadenoma in both sexes, but most frequently in females. Testicular interstitial adenoma in males and stromal polyp of the uterus in females was observed. All these neoplasms were similar in type, time of onset, and incidence in both controls and disulfoton treated animals.

The study is classified as **Acceptable** and **satisfies** the guideline requirement for a chronic feeding/carcinogenicity study (83-5) in the rat.

Chronic Feeding/Oncogenicity Study/Rats (83-5)

CITATION: Carpy, S.; Klotzsche, C.; Cerioli, A. (1975) Disulfoton: 2-Year Feeding Study in Rats. Sandoz, Ltd., Switzerland. Report No. 47069. December 15, 1976. MRID 00069966. Unpublished.

EXECUTIVE SUMMARY: In a chronic feeding/carcinogenicity study (MRID 00069966) Technical Di-Syston® (95.7% a.i.) was administered to 60 SPF Sprague-Dawley rats/sex/dose in the diet at dose levels of 0, 0.5/5.0, 1.0 or 2.0 ppm (0, 0.0215/0.1900, 0.0456, or 0.0893 mg/kg/day in males and 0, 0.0267/0.1960, 0.0419 or 0.1033, mg/kg/day in females, respectively; calculated) for 104 weeks. The 0.5 ppm dose was fed for 81 weeks, then increased to 2 ppm because of no effects seen at the 1 ppm dose level. The rats in the 2 ppm group were initially maintained at 1.5 ppm for 4 - 5 weeks, then increased to full dose. Body weight, food consumption, food efficiency, hematology, clinical chemistries, and urinalysis were determined. Plasma, red cell and brain cholinesterase was determined from 5 overnight fasted animals/sex/group at termination. Necropsy

was done on 10 animals/sex/dose; all others were examined for tumors. Histopathology was done on 5 animals/sex from the control and the 5 ppm group.

Treatment with Di-Syston did not effect, food consumption, body weight gain, hematology, clinical chemistry, and urinalysis. Mortality was high (20 - 37%) in females but lacked the dose response and no clear explanation was offered for cause of death; more than 1/3 of the dead animals autolyzed. At 0.5/5 ppm, in males the absolute/relative liver, spleen and kidney weights increased 12%/8%, 21%/17% and 23%/19%, respectively ($P \leq 0.05$); however, the histopathology of the organs were unremarkable. There was a trend for decreased absolute and relative brain weights in males and increased trend in females. The **Systemic Toxicity LOEL >1 ppm**.

Cholinesterase levels in plasma, red cells and brain was inhibited in males and females at two higher doses and it was dose-related. At 2 ppm, the plasma, red cell and brain ChE of males was inhibited 14, 9.3, 9%, and in females 22, 13.3 and 17%, respectively, compared to the controls. At the 0.5/5 ppm dose, plasma, red cell and brain ChE of males and females was inhibited 20 - 39.6, 18.3 - 27.1 and 25 - 36%, respectively. ChE levels in the 1 ppm group males and females was not effects. The **ChE NOEL = 1 ppm and the LOEL = 2 ppm**, based on decreased plasma, red cell and brain cholinesterase levels.

The study is classified as **Unacceptable** and can not upgraded because multiple deficiencies in the conduct of the study and **does not satisfy** the guideline requirement for chronic toxicity/oncogenicity study (83-5) in the rat.

Developmental Toxicity Study in Rats (83-3)

CITATION: Lamb-DW and Hixson-EJ (1983) Embyrotoxic and teratogenic effects of Disulfoton. Study# 81-611-02 submitted by Mobay Chem. Corp. May 13, 1983. MRID#: 00129458. Unpublished Report.

EXECUTIVE SUMMARY: Disulfoton, technical (98.2%) was administered in a carbowax (polyethylene glycol 400) vehicle by gavage to 25 pregnant Sprague Dawley rats/group at 0, 0.1, 0.3 or 1.0 mg/kg/day from day 6 through day 15 of gestation (MRID# 00129458). On day 21, the rats were killed and 50% of each litter was examined for skeletal anomalies and the remainder for visceral anomalies. Cholinesterase inhibition studies on the dams at 21 days (2 weeks dosing) indicated an NOEL/LOEL of 0.1/0.3 mg/kg/day based on 41% inhibition of both plasma and erythrocyte cholinesterase. Fetuses showed incomplete ossification of the intraparietals and sternebrae at 1.0 mg/kg/day.

The NOEL/LOEL for maternal toxicity were 0.1/0.3 mg/kg/day based on 41% inhibition of both plasma and erythrocyte cholinesterase. The NOEL/LOEL for developmental toxicity were 0.3/1.0 mg/kg/day based on incomplete ossification of the intraparietals and sternebrae.

The study is acceptable under Guideline 83-3 for a developmental toxicity study in rats.

Developmental Toxicity in Rabbits (83-3)

CITATION: Tesh-JM et al. (1982) S276: Effects of oral administration upon pregnancy in the rabbit. An unpublished report (Bayer No. R 2351) prepared by Life Science Research, Essex, England and submitted to Bayer AG, Wuppertal, Germany. Dated December 22, 1982. MRID# 00147886. Unpublished Report.

EXECUTIVE SUMMARY: Disulfoton, technical was administered by gavage in a corn oil vehicle (5ml/kg) to 15, 14, 14 or 22 pregnant New Zealand White rabbits per group at 0, 0.3, 1.0 or 3.0 mg/kg/day, respectively from day 6 to 18 of gestation (MRID# 00147886). Since mortality and clinical signs were observed at 3.0 mg/kg/day, this dose level was reduced to 2.0 mg/kg/day and finally to 1.5 mg/kg/day. Analysis showed that the dosing solutions were 17, 14 and 10% below the target concentrations for the low to highest doe tested (HDT), respectively. Females were artificially inseminated.

Maternal signs such as muscle tremors, unsteadiness/ incoordination and increased respiratory rate were seen 4 hours after dosing and in some cases persisted for more than 24 hours at the HDT. No toxic signs were noted at the MDT and LDT. At the MDT one low and 3 control females were found dead or moribund from a mid-ear disease or respiratory infection. Test material related mortalities at the HDT occurred mostly prior to dosage reduction to 1.5 mg/kg. Nine of 22 animals survived to termination at the HDT. Two animals aborted at the MDT. No test material related body weight changes were noted.

No dose related soft tissue or skeletal anomalies were noted at any dose levels.

The NOEL/LOEL for dams were 1.0/1.5 based on tremors, unsteadiness/incoordination and increased respiration. The NOEL/LOEL for developmental toxicity were >3.0/>3.0 mg/kg/day.

The study is acceptable for Guideline 83-3 for a developmental toxicity study in rabbits and was upgraded from supplementary to fully acceptable in HED Doc# 004698 and by the RfD/QA Peer Review Committee.

Two-Generation Reproductive Toxicity Study/Rats (83-4)

CITATION: Astroff, A Barry (1997) A Two Generation Reproductive Toxicity study with Disulfoton Technical (Disyston ®) in the Sprague Dawley Rat. Laboratory name Bayer Corp., Stilwell, KA. Laboratory report number: 95-672-FZ, report# 108002, File 8368. November 19, 1997. MRID# 44440801. Unpublished

EXECUTIVE SUMMARY: In a 2-generation reproduction study (MRID# 44440801) disulfoton, technical, 99% a.i.] was administered to 30 Sprague Dawley rats/sex/dose in the diet at dose levels of 0, 0.5, 2.0 or 9.0 ppm (0, 0.025, 0.10 or 0.45 mg/kg/day by std. tables). Dosing was continuous for the P0 and F1 generation. Only one littering/animal/group was conducted. In this second 2-generation reproductive toxicity study with disulfoton, cholinesterase activity was measured in adults during pre-mating (at 8 weeks) and at termination and in pups at postnatal day 4 and day 21 in the 2 generations.

The major effects noted were cholinesterase inhibition and dams with no milk. In P0 males, plasma cholinesterase (PCHE) was significantly depressed and dose related pre-mating at 9.0 ppm (≥-34%) and at termination at 2.0 (≥-11%) and 9.0 ppm (-46%). In P0 females, plasma cholinesterase (PCHE) was significantly depressed pre-mating (≥-29%) and at termination (≥-52%) at ≥2.0 ppm. In P0 males and females erythrocyte cholinesterase (ECHE) was significantly depressed and dose related at ≥2.0 ppm (≥-38% & ≥-35% males and ≥-46% & ≥-80% females) a pre-mating and termination, respectively, but only in females at termination (≥-14%) at ≥0.5 ppm. In P0 males and females brain cholinesterase (BCHE) was significantly depressed and dose related at ≥2.0 ppm in males (≥-11%) and ≥-14% in females at ≥0.5 ppm.. PCHE and ECHE depression in F1 males and females followed a similar nominal pattern to that in P0 males and females, except that the statistical significance varied within the F1 between two dose levels; sometimes the dose level showing statistical significance was higher and sometime lower of the two. In F1 males and females, BCHE was significantly depressed and dose related at ≥2.0 ppm in males (≥-14%) and in females (≥-50%). In F1 and F2 male and female pups at day 4 and/or day 21 of lactation, PCHE and ECHE were significantly depressed at 9.0 ppm. Values for PCHE and ECHE, respectively were at day 4 or day 21 in F1 male pups were (-24% & -47%) and for F1 female pups (-31% & -43%). Values for PCHE and ECHE, respectively, were at day 4 or day 21 in F2 male pups were (-46% & -53%) and for F2 female pups (-48% & -51%). In F1 and F2 male and female pups BCHE was significantly depressed at day 4 and day 21 at 9.0 ppm only (day 4 = -14% F1 males and -17% F1 females)(day 21 = -19% F1 males and -23% F1 females)(day 4 = -11% F2 males and -13% F2 females)(day 21 = -35% F2 males and -37% F2 females).

Muscle fasciculation (1 P0 female), tremors (15 P0 females, 10 F1 females) and dams (7 F1 dams) with no milk were noted at 9.0 ppm. No treatment related organ weight changes or histopathology were noted in P0 or F1 males or females at any dose level.

Clinical observations indicate that dams were not caring for their pups. Observed affects in pups in the 9.0 ppm group included 12 F1 (2 dams) pups cold to the touch and 3 F1 (2 dams) not being cared for and 63 F2 pups (7 dams) with no milk in their stomachs and 93 F2 weak pups (10 dams) from the affected dams. In addition, 1 P0 dam was salivating and gasping and did care for the litter and the litter died at 2.0 ppm. This effect at 2.0 ppm was considered test material related by the summary author of the 6(a)(2) submission (See summary 6(a)(2) report, MRID# 44440801; memorandum from David Anderson to PM 53, dated March 24, 1998, D242573), but ignored in the final report summary. Findings at necropsy were noted in F2 pups at 9.0 ppm that were expected in view of the maternal toxicity at this dose level. The report reasonably considered the pup deaths due to failure of maternal care, because of the weak and cold to the touch pups and failure of the

pups to show milk in their stomachs. On careful examination of the report, this reviewer agrees with this conclusion. Thus, under these conditions, the effects in pups were caused by maternal toxicity and not the direct toxicity of disulfoton on pups.

Body weight change was lower than control values during gestation in P0 (-9%) and F1 (-15%) females. Body weights were significantly reduced at termination from control values in P0 (-6%) and F1 females (-13%) and in F1 males (-8%). No other significant body weights or changes were noted.

The P0 parental LOELs were 0.5 ppm (0.025 mg/kg/day) based on brain cholinesterase activity depression in P0 females with tremors and muscle fasciculation at 9 ppm in females during gestation and lactation from both generations and with body weight decrements at 9.0 ppm, especially at termination. A NOEL of 0.5 ppm (0.025 mg/kg/day) was seen in F1 parents. F1 and F2 pup (4 day and 21 day old) cholinesterase activity, including brain cholinesterase activity was depressed only at 9.0 ppm (0.45 mg/kg/day) with 2.0 ppm (0.10 mg/kg/day) being the NOEL. The F1 pup NOEL/LOEL were 2.0/9.0 ppm (0.10/0.45 mg/kg/day) based on treatment related pup deaths and pup weight decrements at 9.0 ppm, probably from inadequate maternal care.

The reproductive study in the rat is classified acceptable and does satisfy the guideline requirement for a 2-generation reproductive study (OPPTS 870.3800, §83-4) in rat.

Two-Generation Reproductive Toxicity/Rats (83-4)

CITATION: Hixson, EJ and Hathaway, TR (1986) Effect of disulfoton (Di-Syston®) on reproduction in the rat. Conducting laboratory: Mobay Chem. Date: 2/12/86. Study# 82-671-02. MRID# 00157511. Unpublished Study.

EXECUTIVE SUMMARY: In an acceptable 2-generation reproductive toxicity study (MRID# 00157511; HED Doc# 011959 & 005796), disulfoton, technical (97.8%) was administered at 0, 1, 3 or 9.0 ppm (0, 0.04, 0.12 or 0.36 mg/kg/day). In this first and older reproduction study cholinesterase activity was measured in pups, but not in adults. In this first study of reproductive toxicity, the parental toxicity NOEL/LOEL were 3/9 ppm or 0.12/0.36 mg/kg/day based on nominally reduced incidence of females with sperm and reduced body weight in gestating and lactating P0 females with cholinesterase being probably inhibited with a NOEL/LOEL of 1/3 ppm or 0.04/0.12 mg/kg/day. These latter cholinesterase results were supported by results from the chronic/oncogenicity rat study. Toxicity on reproduction showed a NOEL/LOEL of 1/3 ppm or 0.04/0.12 mg.kg/day based on F1a weanling pup brain cholinesterase inhibition and F2b pup survival.

The study is acceptable for a guideline (83-4) study on reproduction in the rat.

GENE TOXICITY TESTING: The following was taken from a document written by Nancy McCarroll for the Hazard Identification Assessment Review Committee proceedings. Combining the acceptable studies with the additional EPA-sponored studies will satify the Pre-1991 mutagenicity initial testing battery guidelines. No further mutagenicity testing has been identified at this time. In addition, disulfoton is not genotoxic *in vivo* or carcinogenic in mice or rats.

In some of the mutagenicity studies, positive effects were seen without activation while negative effects were seen with activation. This may be due to microsomal enzyme metabolism, since pretreatment of rats and mice with phenbarbital reduces toxicity from disulfoton.

Gene Mutation (84-2)

MUTAGENICITY: *Salmonella typhimurium/Escheerichia coli* reverse gene mutation plate incorporation assay (Accession No. 00028625; Doc. No. 003958: As part of an Agency sponsored mutagenicity screening battery, disulfoton was negative in all strains up to the HTD (5000 μg/plate +/- S9) in three independent trials.

MUTAGENICIY: Chinese hamster ovary (CHO) cell HGPRT forward gene mutation assay (MRID# 40638401, Doc# 008394): This unacceptable study is considered to be positive, because the assay was conducted at partially soluble levels(0.1-1.0 μL/ml -S9; 0.7-1.0 μL/ml +S9) and insoluble doses (5-10 μL/ml -S9; 3-10 μL/ml +S9) but not active at soluble concentrations ($\leq$0.06 μL/ml +/-S9). The mutagenic response appeared to be stronger without metabolic (S9) activation .

Chromosome Aberrations (84-2)

CITATION: Micronucleus Test on the Mouse, performed by Bayer AG, Wuppertal (Germany), Study No. T2059008/Bayer Final Report No. 23887, dated January 13, 1995. (MRID No. 43615701). Unpublished. report.
Conclusions: This study is judged acceptable, as demonstrating no increase over background in micronucleated polychromatic erythrocytes (evidence of cytogenetic damage) of mice treated intraparitoneally up to MTD levels (8 mg/kg). Lethality and other signs of toxicity, but no bone marrow cytotoxicity was seen.

Other Gene Mutations: (84-2)

Bacterial DNA Damage/Repair: *E Coli* DNA damage/repair test (Accession# 072293; Doc# 004698): The test is negative up to the HDT (10,000 μg/plate +/- S9.

Mitotic Recombination: *Saccharomyces cerevisiae* D3 mitotic recombination assay (Accession# 00028625; Doc# 003958): Disulfoton (up to 5% +/- S9) was negative at this endpoint in the Agency-sponsored mutagenicity screening battery. The study is currently listed as unacceptable, but should be upgraded to acceptable. Upon further review of the data, it was decided that the reason

for rejecting the study (number of replicates/dose not provided) did not interfere with the interpretation of the findings.

Sister Chromatide Exchange: Sister chromatide exchange in CHO cells (MRID# 4095001; Doc# 008394): Positive, dose related effects at 0.013-0.1 μL/ml without S9, but not active in the S9 activated phase of testing up to a level (0.20 μL/ml) causing cell cycle delay.

Sister Chromatide Exchange: Sister chromatide exchange in chiniese hamster V79 cells (Accession# 072293; Doc# 0044223): The test is negative without activation up to the HTD (80 μg/ml). Subsequently tested by the same investigators (Chen et al., 1982; Environ. Mutagen. 4: 621-624) in the presence of exogenous metabolic activation and found to be negative up to the HDT (80 μg/ml).

Unscheduled DNA Synthesis (UDS): UDS in WI-38 human fibroblasts (Accession# 000028625; Doc# 003958): The test is positive in the absence of S9 activation at percipitating doses (1000-4000 μg/ml). With S9 activation, the study was negative at comparable percipitating concentrations.

Other EPA Sponsored Studies:

Disulfoton was also included in second tier mutagenicity test battery performed at the EPA (EPA-600/1-84-003) in 1984. Although DERs have not been prepared for these additional assays, we assess that they are acceptable for regulatory purposes.

Mouse Lymphoma L5178Y TK+/- forward gene mutation assay: The test was positive in the absence of S9 activation with concentration dependent and reproducible increases in mutation frequency at 40-90 μg/ml; higher dose levels were cytotoxic. No mutagenic activity was seen in the presence of S9 activation up to a cytotoxic dose (150 μg/ml).

Mouse Micronucleus Assay: The test is negative in Swiss Webster mice up to a lethal dose (8 mg/kg) administered once daily for 2 consecutive days by intraperitoneal injection. No bone marrow cytotoxicity was seen.

Sister Chromatide Exchange in CHO cell assay: The nonactivated test was negaitve up to levels ($\geq$0.02%) that caused cell cycle delay, but the test material was weakly positive at a single dose (0.04%) with metabolic activation.

Metabolism: (85-1)

CITATION: Lee, SGK, Hanna, LA, Johnston, K and Ose, K (1985) Excretion and Metabolism of Di-syston® in Rats. Study# 90946. Dated December 9, 1985, September 20, 1988, May 17, 1990 seotember 26, 1990 and April 29, 1992. Conducted by Mobay Corp. MRID# 42565101.

EXECUTIVE SUMMARY: The aborption, distribution, metabolism and excretion of Di-systion® were studied in groups of male and female Sprague Dawley rats administered a single dose of 0.2 or 1.0 mg/kg Di-syston® - ethylene-1-^{14}C, or a 14-day repeat oral dose of 0.2 mg/kg unlabeled Di-Syston® followed by 0.2 mg/kg [^{14}C]-labeled Di-Syston® on day 15. [^{14}C]-Di-Syston® was rapidly absorbed, distributed, metabolized completely and eliminated in rats under all dosing regimens. Over 95% of the recovered label was excreted in the urine in all groups, and excretion was approximately 90% complete within24 hours of dosing. Less than 2% of the recovered label was in the feces. Bioaccumulation was also not observed, with ≤0.3% of the radiolabel recovered in the tissues and ≤1% in the carcass.

A major metabolite (43-60% of the radioactivity in the urine) and a minor metabolite (6-20% of the urinary radioactivity) were produced by hydrolysis of oxidative metabolites. These metabolites were identified as sulfonyl [1-(ethylsulfonyl)-2-(methylsulfinyl)ethane] and sulfinyl [1-(ethylsulfinyl)-2-(methylsulfinyl)ethane], respectively. Three minor oxidative metabolites (Di-Syston sulfone, Di-Syston oxygen analogue sulfoxide, and Di-Syston oxygen analog sulfone) were identified. Sex-related differences in pattern of these metabolites and differences between the single dose and the repeat dose groups were attributed to differences in metabolic rates, rather than different metabolic pathways. A metabolic pathway for Di-Syston was proposed.

Study classification: The study is classified as acceptable. The study satisfies the registration requirements under Guideline 85-1 (and Addendum 7) for metabolism in rats. Althjough there were minor deficiencies in the study, they did not affect the overall study results and conclusion (see Reviewer's Discussion, Section E). A metabolite was not fully characterized, however, the testing laboratory inducated that after using different solvents the metabolite co-chromatographed with a oxygenated hydrolytic product of disulfoton, 1-(ethylsulfonyl)-2-(methylsulfinyl)ethane and material at the origin co-chromatographed with 1-(ethylsulfinyl)-2-(methylsulfinyl)ethane.

Dermal Absorption/Rats (85-3)

CITATION: Warren, D.L. (1994) Dermal Absorption of ^{14}C-Disulfoton from the DISYSTON 8 Formulation. Miles, Stilwell, KS. Study No. 94-722-YP. August 30, 1994. MRID 43360201. Unpublished.

EXECUTIVE SUMMARY: In a dermal absorption study (MRID 43360201) ^{14}C-Disulfoton (99.3% a.i., Specific activity 53 mCi/mmol; cold disulfoton 86.5% a.i.) in 150μl emulsion was applied to clipped backs (≈ 15 cm^2 area) of 4 male rats/dose/group at dose levels of 0.85, 8.5, and 85 μg/cm^2 for 1, 4, and 10 hours (MRID# 43360201). At the 10th hour all the skins were washed to terminate the exposure. At the termination of exposure, these animals were kept for an additional 158 hours to determine kinetics of absorption and excretion of the material remaining on/in the skin following washing. Following the application of the material, the rats were placed individually in metabolism cages and total urine and feces collected separately. Following the wash of the application site, the

urine and feces were collected in 24 hour aliquots.

Disulfoton is well absorbed and about 31 - 37% and 2.7 - 3.3% of the administered dose was excreted in the urine and feces, respectively. Ten to 30% of the applied dose evaporated during the 10 hours exposure period in all groups. Skin residues as percent of administered dose increased with dose and decreased with time in all groups. The % absorbed increased with time, essentially equal with time. At low dose, the % absorption at 1, 4, and 10 hours was 5.9, 13.7 and 26%; at mid dose it was 4.6, 15.9, and 32.7%; and at high dose 3.6, 12.5 and 25.6%, respectively.

The study is classified as **Acceptable** and satisfies the guideline requirement for dermal penetration study (85-3) in the rat.

Special 6-Month Cholinesterase Study (No Guideline#)

CITATION: W.R. Christenson, B.S. Wahle (1993) Technical grade disulfoton (Di-Syston®): A special 6-month feeding study to determine a cholinesterase no-observed-effect level in the rat. Study# 91-972-IR, (12/3/1993), conducted at Miles Inc., Agricultural Division, Toxicology Stilwell, Kansas for Miles Inc., Agricultural Division, Kansas City, Missouri. MRID No.: 43058401. Unpublished Report.

EXECUTIVE SUMMARY: In a 6-month study designed to establish a NOEL and LOEL for cholinesterase inhibition, technical grade disulfoton (98-99% pure) was administered in the diet to 35 male and female Fischer 344 rats for up to 6 months at levels of 0, 0.25, 0.5 or 1 ppm (approximate doses of 0, 0.02, 0.03 or 0.06 mg/kg/day for males and 0, 0.02, 0.03 or 0.07 mg/kg/day for females)(MRID# 43058401). At the end of 2, 4 and 6 months, 10 rats/sex/dose were taken for blood and brain cholinesterase assays.

Statistically significant inhibition of cholinesterase activity was observed in erythrocytes in females at all doses (3-14% inhibition, 11-17% inhibition, and 23-29% inhibition at 0.24, 0.5, and 1.0 ppm, respectively. In addition, at 1.0 ppm, males had decreased erythrocyte cholinesterase activity (10-16% inhibition) and females had decreased plasma (8-17% inhibition) and brain (7-13% inhibition) cholinesterase activities. However, biologically significant and statistically significant inhibition of cholinesterase activity was observed only in the plasma, erythrocytes and brain of females at 1.0 ppm. No biologically significant inhibition of cholinesterase activity was observed in males.

The LOEL for inhibition of cholinesterase activity was 1.0 ppm is based on a 23-29% inhibition of erythrocyte, 12-17% inhibition of plasma and 13% inhibition of brain cholinesterase in females. The NOEL is 0.5 ppm (0.03 mg/kg/day). No biological meaningful cholinesterase inhibition was observed in males at any dose level.

Body weight, food consumption, and clinical signs were also monitored, but showed no treatment related effects. **Based on these few parameters, no systemic effects were observed at any dose level and the NOEL for systemic toxicity was 1.0 ppm (0.06 mg/kg/day for males and**

0.07 mg/kg/day for females).

Core classification: The special non-guideline study is acceptable for the requested 6-months cholinesterase study in rats.

/ OPP #

APPENDIX 2
The Hazard Identification Assessment Review Committee Report for Disulfoton

David G Anderson

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

012593

OFFICE OF
PESTICIDES AND TOXIC
SUBSTANCES

DATE: April 23, 1998

SUBJECT: ***DISULFOTON:*** Report of the Hazard Identification Assessment Review Committee.

FROM: David G Anderson, Toxicologist 4/22/98
Reregistration Branch-2
Health Effects Division (7509C)
and
Jess Rowland, Executive Secretary 4/22/98
Hazard Identification Assessment Review Committee
Health Effects Division (7509C)

THRU: Clark Swentzel, Chairman 4/22/98
Hazard Identification Assessment Review Committee
Health Effects Division (7509C)
and
Mike Metzger, Co-Chairman 4/27/98
Hazard Identification assessment review Committee
Health Effects Division (7509C)

TO: Alan Nielsen, Branch Senior Scientist
Reregistration Branch-2
Health Effects Division (7509C)

PC Code: 032501

On April 9, 1998, the Health Effects Division's Hazard Identification Assessment Review Committee evaluated the toxicology data base of disulfuton, re-assessed the Reference Dose and select the toxicological endpoints for acute dietary as well as occupational and residential exposure risk assessments. The Committee also addressed the potential sensitivity of infants and children as required by the Food Quality Protection Act (FQPA) of 1996. The Committee's conclusions are presented in this report.

Hazard Identification Assessment Review Committee members in attendance: William Burnum, Robert Fricke, Mike Metzger, Jess Rowland, Clark Swentzel. Members in absentia Karl Baetcke, Karen Hamernik, Melba Morrow. Others in attendance were Pauline Wagner and Jonathan Becker for information on exposure.

Data Presentation:
and
Report Preparation

David G Anderson
Toxicologist

George Ghali
Toxicologist

Report Concurrence:

Jess Rowland
Executive Secretary

I. INTRODUCTION

On April 25, 1996.the Health Effect's Division RfD/Peer Review Committee evaluated the toxicology data base of Disulfoton and established the Reference Dose (RfD) of 0.0003 mg/kg/day based on a NOEL of 0.025mg/kg/day and an Uncertainty Factor of 100 for inter species extrapolation and intraspecies variation *(Memorandum*: G.Ghali toG. LaRoca, April 21, 1997)..

On May 14, 1996.the Toxicology Endpoint Selection Committee selected the doses and endpoints for acute dietary and occupational as well as residential exposure risk assessments (TES Document 6/5/96)..

On November 20, 1997, the Health Effects Division's Hazard Identification Assessment Review Committee (HIARC) re-evaluated the toxicology data base, re-assessed the RfD and selected the toxicology endpoints for acute dietary as well as occupational and residential exposure risk assessments. In addition, the HIARC also addressed the potential enhanced susceptibility of infants and children from exposure to disulfoton as required by the Food Quality Protection Act (FQPA) of 1996.

On April 9, 1998, the HIARC reviewed the results of a two-generation reproduction study in rats (MRID# 44440801) that was recently submitted to the Agency and the impact of this study in the doses and endpoints selected for the various risk assessments. The Committee's conclusions are presented in this report.

II. HAZARD IDENTIFICATION

A. Dietary Hazard

1. Acute Reference Dose (Acute RfD)

Study Selected: Acute Neurotoxicity - Rat §81-8

MRID No. 42755801

Executive Summary: In an acute neurotoxicity screening study, disulfoton (97.8% pure) was administered in a single gavage dose to 10 male Sprague-Dawley rats at doses of 0, 0.25, 1.5, or 5.0 mg/kg and to 10 female Sprague-Dawley rats at doses of 0, 0.25, 0.75 or 1.5 mg/kg. These rats were assessed for reactions in functional observational battery (FOB) and motor activity measurements at approximately 90 minutes post-dosing and on days 7 and 14. Cholinesterase determinations (erythrocyte and plasma) were made at 24 hours post-dosing. Six rats/sex/dose were examined for neuropathological lesions.

At 0.75 mg/kg, 4/10 females had muscle fasciculations. At 1.5 mg/kg, males had muscle fasciculations, diarrhea, and sluggishness and females also had tremors, ataxia, oral staining, decreased activity/sluggishness, decreases in motor and locomotor activity (38–49% of control), and a slightly increased duration of nasal staining. One female at 1.5 mg/kg died from cholinergic intoxication on the day of dosing. At 5.0 mg/kg, males also had symptoms similar to those observed in females at 1.5 mg/kg/day, including reduced motor/locomotor activity (36–45% of control). Recovery appeared to be complete in surviving animals by Day 14. Based on the evidence of neurotoxicity (probably associated with inhibition of cholinesterase) in females at 0.75 mg/kg, the study LOEL is 0.75 mg/kg and the study NOEL is 0.25 mg/kg.

At 0.75 mg/kg in females, cholinesterase activities were inhibited by 53% (erythrocyte) and 30% (plasma) and by 75% (erythrocyte) and 52% (plasma) at 1.5 mg/kg in females. At 5.0 mg/kg in males, cholinesterase activities were inhibited by 21% (erythrocyte) and 25% (plasma). The LOEL for inhibition of cholinesterase activity is 0.75 mg/kg and the NOEL for inhibition of cholinesterase activity is 0.25 mg/kg.

Dose and Endpoints for Risk Assessment: NOEL= 0.25 mg/kg based on neurotoxicity signs, plasma and erythrocyte cholinesterase inhibition in female rats.

Comments about the study and/or Endpoint: This dose and endpoint is appropriate since the toxicological effects were observed following a single oral dose.

Uncertainty Factors (UF): 100 (10 x for inter-species extrapolation, 10 x for intra-species variability.

$$\textbf{Acute RfD} = \frac{\textbf{0.25 mg/kg (NOEL)}}{\textbf{100 (UF)}} = \textbf{0.0025 mg/kg}$$

This risk assessment is required.

2. Chronic RfD

Study Selected: Chronic Feeding Dog §83-1

MRID No. 44248002

Executive Summary: In a chronic toxicity study, disulfoton (97% a.i.%) was administered orally in the diet to purebred beagle dogs (4/sex/dose) at dose levels of 0.5, 4 or 12 ppm (equivalent to 0.015, 0.121 and 0.321 mg/kg/day for males; and 0.013, 0.094 and 0.283 mg/kg/day for females) for one year. Potential ocular and neurologic effects

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were addressed. Plasma cholinesterase was decreased starting at day 7 in the 4.0 ppm dose groups of the study through to termination (males 39% to 46%; females 32% to 45%). Erythrocyte cholinesterase was decreased starting at day 91 in the 4.0 ppm dose groups through to termination (males 23% to 48%; females 17% to 49%). Not all the values at 4.0 ppm were statistically significant, probably because of the wide range in values, but at least 2 animals per group showed biologically significant cholinesterase inhibition. By termination cholinergic effects of the plasma, erythrocytes, brain, and ocular tissues were observed in both sexes in the 4 and 12 ppm treatment groups. Plasma and erythrocyte cholinesterase depression are compared to pretreatment values. Brain, cornea, retina and ciliary body cholinesterase depression are compared with concurrent control values at termination only. In the 12 ppm treatment groups, depressed cholinesterase was observed in plasma (56%-63%), erythrocytes (30%-91%), and brain (32%-33%) compared to their respective controls. In the 4 ppm treatment groups in males and females, cholinesterase was depressed in plasma (38%-46%), erythrocytes (40%- 38%), and brain (females only, 22%). Disulfoton inhibited cholinesterase of the cornea, retina, and ciliary body, but did not appear to alter the physiologic function of the visual system. In the 12 ppm treatment groups, depressed cholinesterase was observed in the cornea (60-67%), ciliary body (45-54%), and retina (males only; 67%). In the 4 ppm treatment groups, cholinesterase was inhibited in the cornea (50-60% lower), and retina (females only, 25%). No treatment-related ophthalmology findings or histological or electrophysiological changes in the retina were observed. No other treatment-related effects were observed. No animals died during the study. No treatment-related effects were observed in systemic toxicity including food consumption, body weights, clinical signs, hematology, clinical blood chemistry or urinalysis parameters, electrocardiogram, electroretinograms or clinical neurological findings, organ weights or gross or microscopic post-mortem changes in any treatment group. No neoplastic tissue was observed in dogs in the treatment and control groups. The LOEL is 4 ppm (0.094 mg/kg/day), based on depressed plasma, erythrocyte, and corneal cholinesterase levels in both sexes, and depressed brain and retinal cholinesterase levels in females. The NOEL is 0.5 ppm (0.013 mg/kg/day). These LOEL/NOEL for plasma cholinesterase inhibition extend from day 7 to termination and for erythrocyte cholinesterase inhibition they extend from day 91 to termination.

Dose and Endpoint for Establishing the RfD: The NOEL is 0.5 ppm (0.013 mg/kg/day) based on depressed plasma, erythrocyte and corneal cholinesterase levels in both sexes and depressed brain and retinal cholinesterase levels in females.

Uncertainty Factors (UF): 100 (10 x for inter-species extrapolation, 10 x for intra-species variability.

$$\textbf{Chronic RfD} = \frac{\textbf{0.013 mg/kg (NOEL)}}{\textbf{100 UF}} = \textbf{0.00013 mg/kg}$$

This risk assessment is required.

B. Occupational/Residential Exposure

1. Dermal Absorption; **§ 85-2**

MRID No.: 43360201

Percentage absorbed: At 1, 4 or 10 hours, the following percentages of applied dermal doses were absorbed in the rat. Application site was washed after the 10 hour exposure and the 168 hour exposure (168 hour exposure data not given). Disulfoton is volatile and 10% to 30% of the applied dose was found to be volatile over a 10 hour period. The volatility of disulfoton is probably the reason for some of the low recoveries, but since volatility would also be present under field conditions it was not considered in the percentage absorption.

Dose in ($\mu g/cm^2$ on a 15 cm^2 site) & mg/kg based on 250 g rat	Exposure hours	Percentage absorbed
Concentration administered (0.85 $\mu g/cm^2$)		
0.051 mg/kg	1	5.9
0.051 mg/kg	4	13.9
0.051 mg/kg	10	26.0
Concentration administered (8.5 $\mu g/cm^2$)		
0.51 mg/kg	1	4.6
0.51 mg/kg	4	15.9
0.51 mg/kg	**10**	**36.2***
Concentration administered (85 $\mu g/cm^2$)		
5.1 mg/kg	1	3.6
5.1 mg/kg	4	12.5
5.1 mg/kg	10	25.3

* = % dermal absorption factor chosen by TES of 5/14/96.

Dermal Absorption Factor: 36% at approximately 8.5 $\mu g/cm^2$ or 0.51 mg/kg for 10 hours should be used to convert oral studies to dermal studies where necessary.

Comments about the Study Endpoint: The TES Committee indicated that dermal absorption of 36%, obtained after 10 hours exposure at a concentration of 8.5 $\mu g/cm^2$ (0.51 mg/kg), should be used for correcting oral dosing to dermal dosing. If the exposure deviates by a large amount from 8.5 $\mu g/cm^2$ for 10 hours then a different percentage dermal absorption may be appropriate. The risk assessor should refer to the above table or HED Doc# 011316, MRID# 43360201, for a more complete understanding of the dermal absorption percentage and the relationship between percentage absorption and the dose applied to the skin. The HIARC concurred with the TES Committee on this approach for the use of the dermal absorption factor.

2. Short Term Dermal - (1-7 DAYS)

Study Selected: 21-day dermal study in rabbits §82-3

MRID No. 00162338

Executive Summary: In a 21-day dermal study, disulfoton, technical (97.8%) was administered dermally in a Cremophor EL emulsion to 5 New Zealand White rabbits/sex/group at 0, 0.4, 1.6 or 6.5 mg/kg/day for 15 separate exposures, 5 day/week for 6 hours/day for 21 days. No skin irritation occurred at any dose level. Females at the 6.5 mg/kg/day died (a total of 6) after 1-3 weeks of treatment and males (unknown numbers) died at 6.5 mg/kg/day after 3 days and 2 weeks of treatment. At 1.6 mg/kg/day, plasma cholinesterase was inhibited (41%) in females and (32%) in males after 1 week of treatment. At the same dose level, erythrocyte cholinesterase was inhibited (16% from pre-dosing values, but 21% from the concurrent control at 2 weeks and at termination 33% from control, but increased 3% from pre-dose values. Brain cholinesterase was marginally inhibited at 1.6 mg/kg/day in females (8%) and in males (7%) at termination (3-weeks).
The NOEL was 0.4 mg/kg/day based on plasma, erythrocyte and brain cholinesterase inhibition in females and males.

Dose and Endpoint for use in risk assessment: NOEL = 0.4 mg/kg/day was based on plasma, erythrocyte cholinesterase inhibition after 1 week of dosing.

Comments about study and/or endpoint: This endpoint and the NOEL is supported by a developmental toxicity study in the rat. In that study the maternal NOEL was 0.1 mg/kg/day based on 41% for both plasma and erythrocyte cholinesterase inhibition. When the 36% dermal absorption factor is used, the comparable dermal dose is 0.3 mg/kg/day [i.e., oral NOEL of (0.1 mg/kg/day)/(0.36) = 0.3 mg/kg/day] The study represents cholinesterase inhibition after 2 weeks of dosing.

This risk assessment is required.

3. Intermediate Term O/R Exposure (1 Week to Several Months):

Study Selected - Special 6-months cholinesterase study.

MRID No.: 43058401

Executive Summary: In a 6-month study designed to establish a NOEL and LOEL for cholinesterase inhibition, technical grade disulfoton (98-99% pure) was administered in the diet to 35 male and female Fischer 344 rats for up to 6 months at levels of 0, 0.25, 0.5 or 1 ppm (approximate doses of 0, 0.02, 0.03 or 0.06 mg/kg/day for males and 0, 0.02, 0.03 or 0.07 mg/kg/day for females). At the end of 2, 4 and 6 months, 10 rats/sex/dose were taken for blood and brain cholinesterase assays. Statistically significant inhibition of cholinesterase activity was observed in erythrocytes in females at all doses (3-14% inhibition, 11-17% inhibition, and 23-29% inhibition at 0.24, 0.5, and 1.0 ppm, respectively. In addition, at 1.0 ppm, males had decreased erythrocyte cholinesterase activity (10-16% inhibition) and females had decreased plasma (8-17% inhibition) and brain (7-13% inhibition) cholinesterase activities. However, biologically significant and statistically significant inhibition of cholinesterase activity was observed only in the plasma, erythrocytes and brain of females at 1.0 ppm. No biologically significant inhibition of cholinesterase activity was observed in males. The LOEL for inhibition of cholinesterase activity was 1.0 ppm is based on a 23-29% inhibition of erythrocyte, 12-17% inhibition of plasma and 13% inhibition of brain cholinesterase in females. The NOEL is 0.5 ppm (0.03 mg/kg/day). No biological meaningful cholinesterase inhibition was observed in males at any dose level. Body weight, food consumption, and clinical signs were also monitored, but showed no treatment related effects. Based on these few parameters, no systemic effects were observed at any dose level and the NOEL for systemic toxicity was 1.0 ppm (0.06 mg/kg/day for males and 0.07 mg/kg/day for females).

Dose and Endpoint for use in risk assessment: NOEL=0.03 mg/kg/day was based on plasma, erythrocyte and brain cholinesterase inhibition in female rats.

Comments about study and/or endpoint: Since an oral NOEL was identified, a dermal absorption factor of 36% should be used for this risk assessment. This endpoint is supported by similar effects (plasma, erythrocyte and brain cholinesterase inhibition) observed in a subchronic neurotoxicity study in rats (MRID# 42977401). In addition, the new 2-generation study on reproduction (MRID# 44440801) also supports the 6-month cholinesterase study endpoints.
The Committee considered a combination of factors in the decision to use the NOEL of 0.5 ppm (0.03 mg/kg/day) from the 6-month cholinesterase study in rats for the this exposure assessment instead of the LOEL of 0.5 ppm (0.03 mg/kg/day) from new 2-generation study on reproduction. Considered were that test material consumption was measured in the 6-month cholinesterase study and the measurements were invalid in the new 2-generation study on reproduction and the 6-month study was specifically designed to determine cholinesterase inhibition. Thus, mg/kg/day were measured in the 6-months study, but mg/kg/day dose levels in the reproduction study were approximated from standard tables. In addition, adult P0 females showed marginal brain cholinesterase

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inhibition while the F1 adult females, dosed similarly, showed none.

This risk assessment is required.

4. Long-Term Dermal (Several Months to Life Time)

Study selected: Chronic Toxicity -Dog §83-1

MRID No. 44248002

Executive Summary: See summary under Chronic RfD.

Dose and Endpoint for Risk Assessment: NOEL=0.013 mg/kg/day based on depressed plasma, erythrocyte and corneal cholinesterase levels in both sexes and depressed brain and retinal cholinesterase levels in females.

Comments about study and/or endpoint: This dose was used to establish the chronic RfD. Since an oral NOEL was identified, a dermal absorption factor of 36% should be used for this risk assessment.

This risk assessment is required.

5. Inhalation Exposure (Any Time Period)

Study Selected: 90-Day Inhalation-Rat §82-4

MRID No.: 41224301

Executive Summary: Disulfoton was administered by inhalation to 12 Fisher 344 rats per sex per group for air control, polyethylene glycol-400: 50% ethanol vehicle control, 0.015, 0.15 or 1.5 mg/m^3 nominal dose levels for 90-days in a nose only chamber. The analytical determined mean dose levels were 0, 0, 0.018, 0.16 and 1.4 mg/m^3 for male and female rats. The rats were exposed to the test material 6 hours per day, 5 days per week. The particle sizes in the inhalation chambers had a MMAD ± geometric standard deviation of 1.3 ± 1.4, 1.1 ± 1.3, 1.0 ± 1.3 and 1.1 ± 1.4 μm for the two controls, 0.015, 0.15 and 1.5 mg/m^3 nominal dose levels, respectively. The range in mean daily particle sizes had a MMAD of 0.5 ± 1.0 μm to 2.6 ± 1.6 μm. At the highest dose level, plasma cholinesterase was depressed in males (19% and 14% from air controls at 38 days and term, respectively, $p \leq 0.05$) and in females (27% and 31% from air controls at 38 days and term, respectively, $p \leq 0.05$). Brain cholinesterase was depressed in males (29%) and females (28%) at termination. Erythrocyte cholinesterase was depressed in females at 38 days (11% at 38 days, $p \leq 0.05$, not considered biologically relevant) at 0.16 mg/m^3 and higher in males and females at 1.4 mg/m^3 at 38 days and term. Brain cholinesterase was depressed (10%, $p \leq 0.05$) at 0.16 mg/m^3, but this degree of variation was not considered biologically relevant due to variation noted in this parameter. Inflammation of the male nasal turbinates occurred at 1.4 mg/m^3. No other test material related effects were noted. The NOEL/LOEL is 0.16 mg/m^3/1.4 mg/m^3 or 0.00016/0.0014 mg/L for plasma, erythrocyte and brain cholinesterase depression.

Dose and Endpoint for use in risk assessment: NOEL=0.00016 mg/L based on plasma, erythrocyte and brain cholinesterase inhibition.

Comments about study and/or endpoint: This NOEL will be used for inhalation exposure risk assessments for any time period (i.e., Short, Intermediate and Long-term). An inhalation toxicity study with 3 to 5 day exposure was available. In that study, the LOEL was <0.0005 mg/L (lowest dose tested); a NOEL was not established. Although this study could have been used for the Short-Term exposure risk assessment, the HIARC did not use this study because: (I) it demonstrated a LOEL rather than a NOEL; (ii) the use of a LOEL would have required an additional 3 x UF; and (iii) the value derived from the use of the LOEL and 3 UF (0.0005 ÷ 3= 0.00017 mg/kg/day) is comparable the NOEL of 0.00016 mg/L in the 90-day study.

This risk assessment is required.

D. MARGINS OF EXPOSURE FOR OCCUPATIONAL/RESIDENTIAL) EXPOSURES

A Margin of Exposure (MOE) of 100 is adequate for occupational exposure risk assessments. The MOEs for residential exposure will be determine during risk characterization by the FQPA Safety Committee..

E. RECOMMENDATION FOR AGGREGATE EXPOSURE RISK ASSESSMENT

For aggregate exposure risk assessment , the MOE's derived for oral, dermal and inhalation exposures may be combined to obtain a total MOE since a common toxicological endpoint (cholinesterase) was observed during all routes of exposure (oral, dermal and inhalation) in the toxicity studies.

For Short-Term aggregate exposure risk assessment:

$$MOE_{total} = \frac{1}{\frac{1}{MOE_{(oral)}} + \frac{1}{MOE_{(dermal)}} + \frac{1}{MOE_{(inhalation)}}}$$

For Intermediate and Long-Term aggregate exposure risk assessment:

$$MOE_{total} = \frac{1}{\frac{1}{MOE_{(oral+\ oral\ dermal\ equivalent)}} + \frac{1}{MOE_{(inhalation)}}}$$

III. CLASSIFICATION OF CANCER POTENTIAL:

The HED RfD/Peer Review classified disulfoton as a Group E Chemical-Not Classifiable to Carcinogenicity based on the lack of evidence of carcinogenicity study in mice and rats at dose levels adequate to test for carcinogenicity.

IV. FQPA CONSIDERATIONS

1. Neurotoxicity

The acute delayed neurotoxicity study (81-7) was unacceptable, but equivocal for delayed neurotoxicity. Another study has been requested for confirmation. Absolute brain weight was not affected by treatment in the guideline chronic studies in rodents. (The subchronic studies, which were graded unacceptable, were not provided for review.) In the rat study, treatment-related eye lesions were seen (optic nerve degeneration and corneal vascularization) and skeletal muscle atrophy were observed. The optic nerve degeneration was related to orbital sinus bleeding injury, so results were not considered treatment related. These neuropathological findings were not repeated in the 1997 1-year dog study, but cholinesterase levels in the cornea, retina, and ciliary body were depressed with treatment.

In an acute delayed neurotoxicity study, disulfoton (97.8% pure) was administered by gavage at 30 mg/kg to 20 hens; 0.5 mg/kg of atropine was administered (im) 10 minutes before the disulfoton dose and 12.5 mg/kg of PAM-2 was administered (im) 30 minutes after the disulfoton dose. This dosing regimen was repeated at day 22. Five hens were used as a negative control. Five hens were administered atropine and PAM-2 (but no disulfoton) similarly to the disulfoton dosed group as an atropine and PAM-2 control and 10 hens were dosed with tri-O-cresol phosphate (500 mg/kg) as a positive control group. The 30 mg/kg dose level was shown to be lethal to hens without atropine administration. Samples of sciatic nerve, spinal cord (cervical, thoracic and lumbar) and brain (mid-brain, brain stem and cerebellum) were fixed in formalin and histological examination conducted. Pharmacologic signs were observed (loss of equilibrium, decreased activity, diarrhea and locomotor ataxia) in 14/20 hens after the first treatment, which subsided by day 5, except in one hen demonstrating ataxia and torticollis which decreased by day 15. These signs were considered by the report authors to be due to acute effects of disulfoton and not due to delayed neurotoxicity. Body weight of the disulfoton group (91% of the negative control and 94% of the atropine and PAM-2 treated control) and atropine and PAM-2 groups (97% of control) were lower than control hens at termination. Neuropathy in the form of degeneration digestion chambers (18/20 disulfoton treated hens versus 9/10 combined control hens), all grade 1 except one grade 2 pathology was seen at the thoracic level in a control hen, neuronal degeneration all grade 1 in (5/20 disulfoton hens versus 1/10 combined control hens, all grade 1) and axonal swelling all grade 1 (6/20 disulfoton hens versus 5/10 combined control hens) and demyelination all grade 1 (0/20 disulfoton treated hens versus 1/10 combined control hens). Macrophage accumulation occurred in 17/20 (85%) disulfoton treated hens versus 7/10 (70%) combined control hens. Macrophage accumulation an/or lymphocyte accumulation occurred in 4/5 of the disulfoton treated hens and in 1/10 of the combined control hens with neuronal degeneration. However, this accumulation was not always

noted at the same site as the neuronal degeneration. This inflammation in old hens adds uncertainty to the effects seen in the study. The study is suggestive but equivocal for delayed neurotoxic effects.

The study is unacceptable and not upgradable for an acute delayed neurotoxicity study in hens (81-7). Due to the equivocal but suggestive nature of the neurotoxic effects and the use of old hens, another study is required.

In an acute neurotoxicity study in Sprague-Dawley rats (10/sex/group), 97.8% disulfoton was administered by a single gavage dose of 0.25, 1.5, or 5.0 mg/kg in males and 0.25, 0.75, or 1.5 mg/kg in females. The NOEL for neurotoxicity and cholinesterase inhibition was 0.25 mg/kg, based on muscle fasciculations in 4/10 females and plasma and RBC cholinesterase inhibition at the LOELs of 0.75 mg/kg in females and 1.5 mg/kg in males. The incidence and type of clinical, behavioral, and neuromotor signs increased with dose. Females were clearly more sensitive. Neither brain weight nor neuropathology was affected by treatment (MRID 42755801).

In a 90-day subchronic neurotoxicity study, 98.7-99.0% disulfoton was administered to Fischer 344 rats (1 2/sex/group) at dietary levels of 1, 4, or 16 ppm (0.063, 0.270, or 1.08 mg/kg/day in males and 0.071, 0.315, or 1.31 mg/kg/day in females). The systemic NOEL was 1 ppm (0.063/0.071 mg/kg/day for M/F), based upon clinical signs consistent with cholinesterase inhibition (muscle fasciculations, urine staining, increased food consumption) in females at the LOEL of 4 ppm (0.270/0.315 mg/kg/day in M/F). At 16 ppm (1.08/1.31 mg/kg/day in M/F), treatment-related findings in both sexes also included increased reactivity, perianal staining, tremors, increased defecation, decreased forelimb grip strength, decreased motor and locomotor activity, decreased body weight gain, and corneal opacities. Cholinesterase inhibition (plasma, erythrocyte, and brain) was observed at all treatment levels (ChE NOEL≤1 ppm; 0.063/0.071 mg/kg/day for M/F). Clearly females were again shown to be more sensitive. It was noted that clinical signs were persistent throughout this study. There were no treatment-related effects on brain weight. At the high-dose level, neuropathological lesions (nerve fiber degeneration) were observed in the optic nerve, and nerve fiber degeneration was also observed in the thoracic spinal cord. These findings, however, were not judged to be unequivocal evidence of treatment-related neuropathology, since there was a confounding background incidence of these lesions (MRID 42977401).

2. Developmental Toxicity

In a prenatal developmental toxicity study in Sprague-Dawley rats (25/group), 98.2% disulfoton was administered on gestation days 6-15 by gavage in polyethylene glycol 400 at dose levels of 0.1, 0.3, or 1.0 mg/kg/day. Cholinesterase activity was measured in dams (5/group) on gestation day 15. The maternal NOEL was 0.1 mg/kg/day, and the maternal LOEL was 0.3 mg/kg/day, based on 41% inhibition of plasma and RBC cholinesterase. There was no other evidence of maternal toxicity at any treatment level. The developmental NOEL and LOEL were established at 0.3 and 1.0 mg/kg/day, based on incomplete ossification of the intraparietals and sternebrae (MRID 00129458)

In a prenatal developmental toxicity study conducted in New Zealand white rabbits (15-22/group), 97.3% disulfoton was administered by gavage in corn oil (5 ml/kg) at doses of 0.3, 1.0, or 3.0 (reduced to 2.0, then 1.5) mg/kg/day on gestation days 6-18. The maternal NOEL was 1.0 mg/kg/day; the maternal LOEL (1.5 mg/kg/day) was based upon clinical signs of cholinesterase depression (tremors, unsteadiness/ incoordination, and increased respiration, occurring within 4 hours of dosing). In addition, there were a large number of mortalities at the high-dose level. There was no evidence of developmental toxicity (developmental NOEL ≥1.5 mg/kg/day). Neither maternal nor fetal cholinesterase levels were measured (MRID 00147886).

3. Reproductive Toxicity:

In a two-generation reproduction study in Sprague-Dawley rats (25/sex/group), 97.8% disulfoton was administered at dietary concentrations of 1, 3, or 9 ppm (calculated effective doses of 0.81, 2.4, or 76.3 ppm; equivalent to 0.04, 0.12, or 0.36 mg/kg/day mg/kg/day by test material consumption). The parental systemic NOEL was 3 ppm (0.12 mg/kg/day). The parental systemic LOEL was 9 ppm (0.36 mg/kg/day), based on decreased females mated and reduced body weight during gestation and lactation in P females. The offspring NOEL was 1 ppm (0.04 mg/kg/day), and the offspring LOEL was 3 ppm (0.12 mg/kg/day), based on decreased brain cholinesterase activity in F1a weanling pups and on decreased F2b pup survival. Although adult cholinesterase was not measured, the 2-year chronic study indicates that cholinesterase inhibition was most likely occurring at 3 ppm with a NOEL of 1 ppm; this was a conclusion of the 4/25/96 RfD PRC meeting (MRID 00157511).

In a another 2-generation reproduction study, disulfoton, technical, 99% a.i.] was administered to 30 Sprague Dawley rats/sex/dose in the diet at dose levels of 0, 0.5, 2.0 or 9.0 ppm (0, 0.025, 0.10 or 0.45 mg/kg/day by std. tables). Dosing was continuous for the P0 and F1 generation. Only one littering/animal/group was conducted. In this second 2-generation reproductive toxicity study with disulfoton, cholinesterase activity was measured in adults during pre-mating (at 8 weeks) and at termination and in pups at postnatal day 4 and day 21 in the 2 generations. The major effects noted were cholinesterase inhibition and dams with no milk. In P0 males, plasma cholinesterase (PCHE) was significantly depressed and dose related pre-mating at 9.0 ppm (≥-34%) and at termination at 2.0 (≥-11%) and 9.0 ppm (-46%). In P0 females, plasma cholinesterase (PCHE) was significantly depressed pre-mating (≥-29%) and at termination (≥-52%) at ≥2.0 ppm. In P0 males and females erythrocyte cholinesterase (ECHE) was significantly depressed and dose related at ≥2.0 ppm (≥-38% & ≥-35% males and ≥-46% & ≥-80% females) a pre-mating and termination, respectively, but only in females at termination (≥-14%) at ≥0.5 ppm. In P0 males and females brain cholinesterase (BCHE) was significantly depressed and dose related at ≥2.0 ppm in males (≥-11%) and ≥-14% in females at ≥0.5 ppm.. PCHE and ECHE depression in F1 males and females followed a similar nominal pattern to that in P0 males and females, except that the statistical significance varied within the F1 between two dose levels; sometimes the dose level showing statistical significance was higher and sometime lower of the two. In F1 males and females, BCHE was significantly depressed and dose related at ≥2.0 ppm in males (≥-14%) and in females (≥-50%). In F1 and F2 male and female pups at day 4 and/or day 21 of lactation, PCHE and ECHE were significantly depressed at 9.0 ppm. Values for PCHE and ECHE, respectively were at day 4 or day 21 in F1 male pups were (-24%

& -47%) and for F1 female pups (-31% & -43%). Values for PCHE and ECHE, respectively, were at day 4 or day 21 in F2 male pups were (-46% & -53%) and for F2 female pups (-48% & -51%). In F1 and F2 male and female pups BCHE was significantly depressed at day 4 and day 21 at 9.0 ppm only (day 4 = -14% F1 males and -17% F1 females)(day 21 = -19% F1 males and -23% F1 females)(day 4 = -11% F2 males and -13% F2 females)(day 21 = -35% F2 males and -37% F2 females). Muscle fasciculation (1 P0 female), tremors (15 P0 females, 10 F1 females) and dams (7 F1 dams) with no milk were noted at 9.0 ppm. No treatment related organ weight changes or histopathology were noted in P0 or F1 males or females at any dose level. Clinical observations indicate that dams were not caring for their pups. Observed affects in pups in the 9.0 ppm group included 12 F1 (2 dams) pups cold to the touch and 3 F1 (2 dams) not being cared for and 63 F2 pups (7 dams) with no milk in their stomachs and 93 F2 weak pups (10 dams) from the affected dams. In addition, 1 P0 dam was salivating and gasping and did care for the litter and the litter died at 2.0 ppm. This effect at 2.0 ppm was considered test material related by the summary author of the 6(a)(2) submission (See summary 6(a)(2) report, MRID# 44440801; memorandum from David Anderson to PM 53, dated March 24, 1998, D242573), but ignored in the final report summary. Findings at necropsy were noted in F2 pups at 9.0 ppm that were expected in view of the maternal toxicity at this dose level. The report reasonably considered the pup deaths due to failure of maternal care, because of the weak and cold to the touch pups and failure of the pups to show milk in their stomachs. On careful examination of the report, this reviewer agrees with this conclusion. Thus, under these conditions, the effects in pups were caused by maternal toxicity and not the direct toxicity of disulfoton on pups. Body weight change was lower than control values during gestation in P0 (-9%) and F1 (-15%) females. Body weights were significantly reduced at termination from control values in P0 (-6%) and F1 females (-13%) and in F1 males (-8%). No other significant body weights or changes were noted. The P0 parental LOELs were 0.5 ppm (0.025 mg/kg/day) based on brain cholinesterase activity depression in P0 females with tremors and muscle fasciculation at 9 ppm in females during gestation and lactation from both generations and with body weight decrements at 9.0 ppm, especially at termination. A NOEL of 0.5 ppm (0.025 mg/kg/day) was seen in F1 parents. F1 and F2 pup (4 day and 21 day old) cholinesterase activity, including brain cholinesterase activity was depressed only at 9.0 ppm (0.45 mg/kg/day) with 2.0 ppm (0.10 mg/kg/day) being the NOEL. The F1 pup NOEL/LOEL were 2.0/9.0 ppm (0.10/0.45 mg/kg/day) based on treatment related pup deaths and pup weight decrements at 9.0 ppm, probably from inadequate maternal care (MRID# 44440801).

4. Additional Information from the Literature

This summary is provided to develop a comprehensive picture of disulfoton toxicity. The data have not been reviewed in depth, and no statement is made regarding the accuracy or quality of the data or reports.

In a 1988 study by McDonald et al., disulfoton was administered by daily i.p. injection at 2 mg/kg/day to male Long-Evans rats for 14 days. In treated rats, muscarinic receptor binding was decreased and spacial memory was decreased in a T-maze alternation task.

5. Determination of Suseptibility

There is no indication of increased susceptibility of fetuses, infants or children over adults to disulfoton from developmental toxicity studies in rats and rabbits or from two 2-generation studies on reproduction. In these studies, toxicity to the fetus or pups occurred only at higher dose levels than to the adults (dams or parents).

6. Recommendation for Developmental Neurotoxicity Study

The HIARC determined that a **developmental neurotoxicity study** was **not required** based on the following weight-of-the-evidence considerations.

(I) Evidence that support requiring a developmental neurotoxicity study:

- At the high-dose level, neuropathological lesions (nerve fiber degeneration) were observed in the optic nerve, and nerve fiber degeneration was also observed in the thoracic spinal cord of the mammalian subchronic study. These findings, however, were not judged to be unequivocal evidence of treatment-related neuropathology, since there was a confounding background incidence of these lesions.

- There was equivocal evidence of delayed neurotoxicity in the acute delayed neurotoxicity study in the hen.

- In a 1988 study by McDonald et al., disulfoton was administered by daily i.p. injection at 2 mg/kg/day to male Long-Evans rats for 14 days. In treated rats, muscarinic receptor binding was decreased and spacial memory was decreased in a T-maze alternation task. Since these effects occurred only with 75% brain cholinesterase inhibition, they were of questionable relevance to lower dose levels.

(ii) Evidence that do not support a need for a Developmental Neurotoxicity Study:

- Developmental toxicity studies showed no increased susceptibility in fetuses as compared to maternal animals following *in utero* exposures in rats and rabbits.

- The two-generation reproduction toxicity studies in rats showed no increased susceptibility in pups when compared to adults. In addition, the pup deaths at the highest dose level in the second study on reproduction were due to a failure of maternal care and not due to direct toxicity from disulfoton.

- There was no evidence of abnormalities in the development of fetal nervous system in the pre/post natal studies.

- All the animal evidence suggesting neurotoxicity from disulfoton exposure is equivocal at best and it occurs at the highest dose levels only, i.e., because effects were seen in control and statistical significance was not achieved.

7. Determination of the FQPA Safety Factor:

The HIARC, based on the hazard assessment, recommends to FQPA Safety Committee, that the additional 10 x factor should be removed because:

(a) Developmental toxicity studies showed no increased susceptibility in fetuses as compared to maternal animals following *in utero* exposures in rats and rabbits.

(b) Two, 2-generation reproduction toxicity study in rats showed no increased susceptibility in pups when compared to adults.

(c) There was no evidence of abnormalities in the development of fetal nervous system in the pre/post natal studies. No brain weight decreases were seen in any study. The evidence that brain histopathology was equivocally affected in the subchronic neurotoxicity (perfused or unperfused) at the highest dose tested only.

(d) The Committee determined that the unacceptable acute delayed neurotoxicity study in hens was not a data gap and would require another study only for confirmation, since there was only equivocal evidence of delayed neurotoxicity. Therefore, there is insufficient evidence to require a developmental neurotoxicity study.

The final recommendation on the FQPA Safety Factor, however, will be made during characterization by the FQPA Safety Committee.

V. DATA GAPS

There are no data gaps. Another acute delayed neurotoxicity study in hens (81-7) and a NTE study are required only for confirmation.

VI. HAZARD CHARACTERIZATION

All required guideline studies have been adequately conducted and reviewed, except that a submitted acute delayed neurotoxicity study in the hen was considered to be unacceptable and not upgradeable.

Cholinesterase inhibition (plasma, erythrocyte and/or brain) is seen at the lowest dose levels tested in rats, mice, rabbits and dogs. All the endpoints are based on good dose related responses in cholinesterase inhibition. Many of the studies show clinical signs at higher dose levels. Females appear to be more sensitive to cholinesterase inhibition in most studies.

Acute and subchronic neurotoxicity in rats, probably due to the cholinesterase inhibition seen, occurred at higher dose levels than the cholinesterase inhibition. An acute delayed neurotoxicity study in the hen was considered unacceptable and not upgradeable and although another study was requested , it would be considered to be confirmatory only. The criteria for requiring a developmental neurotoxicity study was insufficient, thus the study was considered to be unnecessary. The data base relevant to infants and children was adequate to assess any susceptibility that could have occurred.

Adequate developmental toxicity and reproductive toxicity studies show adult toxicity occurs at lower dose levels than toxicity to the fetus or offspring. Dose related responses in adequate developmental toxicity studies in rats and rabbits show that effects at the lowest dose levels are cholinesterase inhibition. Maternal cholinesterase was inhibited in rats at the two highest dose levels while developmental toxicity in the form of incomplete ossification of the intraparietals and sternebrae occurred at the highest dose level only. In rabbits, treatment related maternal mortality and signs of cholinesterase inhibition, such as tremors, unsteadiness/incoordination and increased respiration within 4 hour after dosing occurred at the highest dose level tested only in the developmental toxicity study in rabbits while no toxic effects were seen in fetuses at the highest dose level tested.

Two 2-generation reproduction studies were conducted on disulfoton. In the first study no cholinesterase was studied in parents, which showed treatment related body weight decrement in females during gestation and lactation and decreased mating success in females at the highest dose level tested. The first generation weanling pups, brain cholinesterase was decreased at the highest dose level tested and decreased survival occurred in the second generation pups. Although, adult cholinesterase inhibition was not measured in adults, the 2-year chronic study indicates cholinesterase inhibition was likely at the mid dose tested in the current study; this was the conclusion of the 4/25/96 RfD/Peer Committee meeting. In the second reproduction study, cholinesterase was measured in adults and offspring, which showed brain cholinesterase inhibition in first generation adult females at the lowest dose tested, but not in second generation females. At the highest dose level tested tremors and muscle fasciculation and body weight decrement occurred in females. First and second generation pups showed significant plasma, erythrocyte and brain cholinesterase inhibition in 4 day and 21 day old male and female pups at the highest dose level tested. Pups weights and survival was also decreased probably due to failure of adequate maternal care and/or adequate milk supply. These decreased pup weights and survival at the highest dose level tested were considered to be due to direct toxicity of disulfoton on the dams and not to the pups.

Acute cholinesterase inhibition was seen at the mid dose level where clinical signs such as muscle fasciculation were seen in a mammalian acute neurotoxicity study. Because of high background lesions, only equivocal neuropathological lesions (nerve fiber degeneration in the optic nerve and thoracic spinal cord) were seen in the subchronic neurotoxicity study at the highest dose level tested (not statistically significant), but cholinesterase inhibition (plasma, erythrocyte and brain) was seen at all dose levels. There is a high degree of confidence in the developmental toxicity studies and studies on reproduction and the dose response curve. The confidence in the neurotoxicity studies in rats is a little less because of the equivocal effects at

the highest dose tested, but the dose response relationship was adequate for the cholinesterase inhibition. The disulfoton sulfoxide, disulfoton sulfone, disulfoton O-analog, disulfoton O-analog sulfoxide and disulfoton O-analog sulfone are toxic metabolites (total of 5), which occur during the studies in rats and therefore these metabolites are included in the toxicity of disulfoton.

There is no required guideline study data gaps. There is no developmental neurotoxicity study, but the HAZID did not believe that one was necessary. There is an unacceptable acute delayed neurotoxicity study in hens that shows equivocal delayed neuropathy. This was considered to be not a data gap and although, other study was requested, the results will be considered to be confirmatory only.

This literature summary is provided to develop a comprehensive picture of disulfoton toxicity. The data have not been reviewed in depth, and no statement is made regarding the accuracy or quality of the data or reports.

In a 1988 study by McDonald et al., disulfoton was administered by daily i.p. injection at 2 mg/kg/day to male Long-Evans rats for 14 days. In treated rats, muscarinic receptor binding was decreased and spacial memory was decreased in a T-maze alternation task. These effects occurred in the presence of -75% BCHE inhibition, therefore the effects may not be relevant at the NOEL for BCHE.

There is no evidence to support increased susceptibility of infants or children. The only possible evidence that offspring may be susceptible to neurotoxic effects is the non-statistically significant equivocal evidence at the highest dose level in the subchronic neurotoxicity study in rats (also not statistically significant).

There is no indication of increased susceptibility of fetuses, infants or children over adults to disulfoton from developmental toxicity studies in rats and rabbits or from two 2-generation studies on reproduction. In these studies, toxicity to the fetus or pups occurred only at higher dose levels than to the adults (dams or parents). Thus, there is no evidence of increased susceptibility to the fetus or to offspring.
Some organophosphates cause effects in pups at lower dose levels than adults, but the percentage is not large. Therefore, the structural relationship of being an organophosphate is insufficient to show increased susceptibility of offspring.

Adverse effects associated with various endpoints noted are plasma, erythrocyte and/or brain cholinesterase inhibition. At higher dose levels than the LOELs for these endpoints are effects possibly related to decreased muscle strength, possible nerve transmission rate, breathing difficulties and death.
These organophosphates have a common mode of action in that they decrease erythrocyte and/or brain cholinesterase in animals and humans. Plasma cholinesterase inhibition is a surrogate for possible muscle and brain cholinesterase inhibition. Neuropathy may result from higher exposures to these inhibitors. The rabbit 21-day dermal study did not show as consistent

cholinesterase inhibition with time as other studies showed. The results were somewhat dependent on whether concurrent controls were used or the values for the individual animals at the beginning of the study were used for comparison.

Cholinesterase inhibition occurred at the LOEL in rats, mice, rabbits and dogs. Therefore the effects are very uniform across species. The female of the species appears to be more sensitive than the male and the cholinesterase inhibition occurs at slightly different dose levels across the species. The cholinesterase inhibition appears to be slightly greater in the female than the male in most studies. There is insufficient studies with common dosage regimens to determine the most sensitive species except that the rat is more sensitive than the mouse in oncogenicity studies.

The dose level causing plasma cholinesterase inhibition was 1/3 that causing death in the rabbit dams in the developmental toxicity study. The LOEL causing brain cholinesterase inhibition in parents was 1/45 of the dose level resulting in offspring mortality in the second 2-generation reproduction study. In the acute neurotoxicity rat study reduced motor function occurred at the LOEL for PCHE, ECHE and BCHE inhibition. In the 90-day neurotoxicity study PCHE, ECHE and BCHE inhibition occurred at about 1/4 (0.063/0.27) the dose level resulting clinical signs.

VII ACUTE TOXICITY ENDPOINTS:

Acute Toxicity of disulfoton, technical

Guideline No.	Study Type	MRID #(S).	Results	Toxicity Category
81-1	Acute Oral	Acc# 072293	LD_{50} = M: 6.2 mg/kg; F:1.9 mg/kg	I
81-2	Acute Dermal	Acc# 07793	LD_{50} = M: 15.9 mg/kg; F: 3.6 mg/kg	I
81-3	Acute Inhalation	Acc# 258569	LC_{50} = M: 0.06 mg/L; F: 0.89 mg/L	I
81-4	Primary Eye Irritation	None	Data requirement waived.	N/A
81-5	Primary Skin Irritation	None	Data requirement waived.	N/A
81-6	Dermal Sensitization	None	Data requirement waived.	N/A
81-7	Acute Delayed Neurotoxicity	00129384	Equivocal	

81-8	Acute Neurotoxicity	42755801	Reversible neurotoxic signs consistent with the cholinesterase inhibition 1.5 mg/kg in females and 5.0 mg/kg in males	N/A

VIII. SUMMARY OF TOXICOLOGY ENDPOINTS

The doses and toxicological endpoints selected for various exposure scenarios are summarized in the table below.

Exposure scenario	Dose (mg/kg/day)	Endpoint	Study
Acute Dietary	NOEL=0.25	Cholinesterase/clinical signs	Acute neurotox/rat
Acute dietary RfD = 0.0025 mg/kg/day			
Chronic dietary	NOEL=0.013	Cholinesterase inhibition	Chronic/Dog
Chronic dietary RfD = 0.00013 mg/kg/day			
Short-term (Dermal)	Dermal NOEL=0.4	Cholinesterase	21-day dermal/rabbit
Correction for dermal absorption unnecessary			
Intermediate-term (Dermal)	Oral NOEL=0.03	Cholinesterase inhibition	6-months chronic/rat
Correction for oral to dermal exposure necessary (36% dermal absorption factor)			
Long-term life time (Dermal)	Oral NOEL=0.013	Cholinesterase inhibition	Chronic/dog
Correction for oral to dermal exposure necessary (36% dermal absorption factor)			
Inhalation (Any time period) (inhalation)	NOEL=0.00016 mg/L	Cholinesterase inhibition	90-day inhalation/rat

Table of values (triplicate analyses on 5 rats/sex) for plasma and erythrocyte cholinesterase inhibition in males and female Wistar rats after 4 hour inhalation exposures (nose only)/day for up to 5 days. The values in the table present % increases in cholinesterase inhibition compared with pre-dose values (Pre) or control © as calculated by {1-[(cholinesterase activity)/(pre-dose cholinesterase activity (Pre)) or (cholinesterase activity in control (C))]} X 100. **The acute inhalation NOEL/LOEL for males and females are 0.0005/0.0018 mg/L based on increased plasma cholinesterase inhibition and NOEL/LOEL of 0.0018/0.0098 mg/L for males and females based increased erythrocyte cholinesterase inhibition after 1 exposure.**

After 3 to 5 exposures, males showed NOEL/LOEL of 0.0005/0.0018 mg/L based on increased plasma and erythrocyte cholinesterase inhibition. Females showed NOEL/LOEL of <0.0005/0.0005 mg/L based on increased plasma cholinesterase inhibition after 3 to 5 exposures and the NOEL/LOEL are 0.0005/0.0018 mg/L based increased erythrocyte cholinesterase after 3 to 5 exposures. Death occurs in females rats after 3 exposures at 0.0098 mg/L. Bolded values appear to be dose related.

Exposure conc. mg/L	After exposure 1				After exposure 3				After exposure 5				72 hr after exposure 5			
	Plasma		Erythrocyte		Plasma		Erythrocyte		Plasma		Erythrocyte		Plasma		Erythrocyte	
	Pre	C	Pre	C	Pre	C	Pre	C	Pre	C	Pre	C	Pre	C	Pre	C
Males (sample size = 5)																
0	-5	0	3	0	-2	0	0	0	4	0	-4	0	2	0	-4	0
0.0005	0	5	4	0	9	11	6	6	14	11	2	4	14	13	-3	1
0.0018	18	17	1	-2	43	40	19	18	53	49	16	19	14	13	12	15
0.0098	71	75	19	15	79	81	33	32	81	81	29	31	25	29	28	28
Females (sample size = 5 except as otherwise specified)																
0	13	0	3	0	18	0	4	0	25	0	1	0	16	0	-1	0
0.0005	22	4	1	0	47	31	6	7	54	34	4	9	26	6	1	7
0.0018	48	40	0	1	81	77	18	17	88	83	22	26	44	34	15	20
0.0098	92	91	24	23	94[a]	92[a]	27[a]	25[a]	93[b]	91[b]	-2[b]	0[b]	75[c]	71[c]	18[c]	22[c]

[a] = Mean of 3/5 rats; 2 died. [b] = Mean of 2/5 rats; 3 died. [c] = 1/5 rats; 4 died. Values for females at 0.0098 mg/L may not be meaningful at the day 5 exposure and after. Data were calculated from the data presented in the Table on page 14 of MRID# 00147754 Thyssen-J (1978)(S276)(Di-syston®A.I.) Acute Inhalation Toxicity Studies. Report# 7827, Bayer AG# or Mobay# 66647. September 27, 1978.

APPENDIX 3
The Dietary Exposure Estimation Model (DEEM™)
Report for Disulfoton

Richard Griffin

RESIDUES FOR ACUTE RISK ESTIMATES

CHEMICAL NAME: Disulfoton
RfD(ACUTE): .000830 mg/kg/DAY NOEL(ACUTE): .250000 mg/kg/day
Date created/last modified: 08-18-1998/14:02:39/8 Program ver. 6.16

Food Code	Crop Grp	Food Name	RESIDUE (ppm)		Adj.Factors #1	#2
260	A	ASPARAGUS	000.100000		01.000	01.000
265	O	BARLEY	000.200000		01.000	01.000
249	G	BEANS-DRY-BROADBEANS	000.750000		01.000	01.000
250	G	BEANS-SUCCULENT-BROADBEANS	000.750000		01.000	01.000
236	G	BEANS-SUCCULENT-YELLOW/WAX	000.750000		01.000	01.000
235	G	BEANS-SUCCULENT-OTHER	000.750000		01.000	01.000
234	G	BEANS-SUCCULENT-GREEN	000.750000		01.000	01.000
233	G	BEANS-SUCCULENT-LIMA	000.750000		01.000	01.000
232	G	BEANS-DRY-PINTO	000.750000		01.000	01.000
231	G	BEANS-DRY-OTHER	000.750000		01.000	01.000
251	G	BEANS-DRY-PIGEON BEANS	000.750000		01.000	01.000
230	G	BEANS-DRY-NAVY (PEA)	000.750000		01.000	01.000
229	G	BEANS-DRY-LIMA	000.750000		01.000	01.000
228	G	BEANS-DRY-KIDNEY	000.750000		01.000	01.000
227	G	BEANS-DRY-GREAT NORTHERN	000.750000		01.000	01.000
253	G	BEANS-UNSPECIFIED	000.750000		01.000	01.000
256	G	BEANS-DRY-HYACINTH	000.750000		01.000	01.000
257	G	BEANS-SUCCULENT-HYACINTH	000.750000		01.000	01.000
258	G	BEANS-DRY-BLACKEYE PEAS/COWPEA	000.750000		01.000	01.000
259	G	BEANS-DRY-GARBANZO/CHICK PEA	000.750000		01.000	01.000
324	U	BEEF-FAT W/O BONES	000.050000		01.000	01.000
325	U	BEEF-KIDNEY	000.050000		01.000	01.000
326	U	BEEF-LIVER	000.050000		01.000	01.000
327	U	BEEF-LEAN(FAT/FREE)W/O BONES	000.050000		01.000	01.000
322	U	BEEF-OTHER ORGAN MEATS	000.050000		01.000	01.000
323	U	BEEF-DRIED	000.050000		01.920	01.000
321	U	BEEF-MEAT BYPRODUCTS	000.050000		01.000	01.000
168	F	BROCCOLI	000.750000		01.000	01.000
169	F	BRUSSELS SPROUTS	000.750000		01.000	01.000
170	F	CABBAGE-GREEN AND RED	000.750000		01.000	01.000
173	F	CABBAGE-CHINESE/CELERY/BOK CHO	000.750000		01.000	01.000
171	F	CAULIFLOWER	000.750000		01.000	01.000
112	A	COFFEE	000.200000		01.000	01.000
172	F	COLLARDS	000.750000		01.000	01.000
237	O	CORN/POP	000.300000		01.000	01.000
267	O	CORN GRAIN-BRAN	000.300000		01.000	01.000
268	O	CORN GRAIN/SUGAR/HFCS	000.300000		01.500	01.000
266	O	CORN GRAIN-ENDOSPERM	000.300000		01.000	01.000
238	O	CORN/SWEET	000.300000		01.000	01.000
388	O	CORN GRAIN/SUGAR-MOLASSES	000.300000		01.500	01.000
289	O	CORN GRAIN-OIL	000.300000		01.000	01.000
290	A	COTTONSEED-OIL	000.750000		01.000	01.000
291	A	COTTONSEED-MEAL	000.750000		01.000	01.000
332	U	GOAT-LIVER	000.050000		01.000	01.000
329	U	GOAT-OTHER ORGAN MEATS	000.050000		01.000	01.000
333	U	GOAT-LEAN (FAT/FREE) W/O BONE	000.050000		01.000	01.000
331	U	GOAT-KIDNEY	000.050000		01.000	01.000
328	U	GOAT-MEAT BYPRODUCTS	000.050000		01.000	01.000
330	U	GOAT-FAT W/O BONE	000.050000		01.000	01.000
176	E	LETTUCE-LEAFY VARIETIES	002.000000		01.000	01.000
192	E	LETTUCE-HEAD VARIETIES	000.750000		01.000	01.000
182	E	LETTUCE-UNSPECIFIED	002.000000		01.000	01.000
319	X	MILK-FAT SOLIDS	000.010000		01.000	01.000
398	X	MILK-BASED WATER	000.010000		01.000	01.000
320	X	MILK SUGAR (LACTOSE)	000.010000		01.000	01.000
318	X	MILK-NONFAT SOLIDS	000.010000		01.000	01.000
399	O	OATS-BRAN	000.750000		01.000	01.000
269	O	OATS	000.750000		01.000	01.000
940	A	PEANUTS-HULLED	000.100000		01.000	01.000
293	A	PEANUTS-OIL	000.100000		01.000	01.000
403	A	PEANUTS-BUTTER	000.100000		01.890	01.000
241	G	PEAS (GARDEN)-GREEN	000.750000		01.000	01.000

240	G	PEAS (GARDEN)-DRY	000.750000	01.000 01.000
405	G	PEAS-SUCCUL./BLACKEYE/COWPEA	000.750000	01.000 01.000
047	R	PECANS	000.100000	01.000 01.000
156	I	PEPPERS-CHILLI INCL JALAPENO	000.100000	01.000 01.000
157	I	PEPPERS-OTHER	000.100000	01.000 01.000
155	I	PEPPERS-SWEET(GARDEN)	000.100000	01.000 01.000
158	I	PIMIENTOS	000.100000	01.000 01.000
347	U	PORK-LEAN (FAT FREE) W/O BONE	000.050000	01.000 01.000
346	U	PORK-LIVER	000.050000	01.000 01.000
345	U	PORK-KIDNEY	000.050000	01.000 01.000
344	U	PORK-FAT W/O BONE	000.050000	01.000 01.000
343	U	PORK- OTHER ORGAN MEATS	000.050000	01.000 01.000
342	U	PORK-MEAT BYPRODUCTS	000.050000	01.000 01.000
211	B	POTATOES/WHITE-PEEL ONLY	000.500000	01.000 01.000
208	B	POTATOES/WHITE-UNSPECIFIED	000.500000	01.000 01.000
207	B	POTATOES/WHITE-WHOLE	000.500000	01.000 01.000
209	B	POTATOES/WHITE-PEELED	000.500000	01.000 01.000
210	B	POTATOES/WHITE-DRY	000.500000	06.500 01.000
338	U	SHEEP-FAT W/O BONE	000.050000	01.000 01.000
337	U	SHEEP-OTHER ORGAN MEATS	000.050000	01.000 01.000
336	U	SHEEP-MEAT BYPRODUCTS	000.050000	01.000 01.000
339	U	SHEEP-KIDNEY	000.050000	01.000 01.000
340	U	SHEEP-LIVER	000.050000	01.000 01.000
341	U	SHEEP-LEAN (FAT FREE)W/O BONE	000.050000	01.000 01.000
275	O	SORGHUM (INCLUDING MILO)	000.750000	01.000 01.000
303	G	SOYBEAN-OTHER	000.100000	01.000 01.000
307	G	SOYBEANS-FLOUR (DEFATTED)	000.100000	01.000 01.000
305	G	SOYBEANS-FLOUR (FULL FAT)	000.100000	01.000 01.000
297	G	SOYBEANS-OIL	000.100000	01.000 01.000
304	G	SOYBEANS-MATURE SEEDS DRY	000.100000	01.000 01.000
306	G	SOYBEANS-FLOUR (LOW FAT)	000.100000	01.000 01.000
159	I	TOMATOES-WHOLE	000.750000	01.000 01.000
423	I	TOMATOES-DRIED	000.750000	14.300 01.000
160	I	TOMATOES-JUICE	000.750000	01.000 01.000
162	I	TOMATOES-PASTE	000.750000	01.000 01.000
163	I	TOMATOES-CATSUP	000.750000	01.000 01.000
161	I	TOMATOES-PUREE	000.750000	01.000 01.000
277	O	WHEAT-GERM	000.200000	01.000 01.000
278	O	WHEAT-BRAN	000.200000	01.000 01.000
279	O	WHEAT-FLOUR	000.200000	01.000 01.000
437	O	WHEAT-GERM OIL	000.200000	01.000 01.000
276	O	WHEAT-ROUGH	000.200000	01.000 01.000

ACUTE RISK ESTIMATES

U.S. Environmental Protection Agency Ver. 6.27
DEEM ACUTE analysis for DISULFOTON (1989-92 data)
Residue file name: 032501ac.R91 Adjustment factor #2 NOT used.
Analysis Date: 10-29-1998/15:10:07 Residue file dated: 08-18-1998/14:02:39/8
Acute Reference Dose (aRfD) = 0.000830 mg/kg body-wt/day

Summary calculations:

	95th Percentile		99th Percentile		99.9 Percentile	
	Exposure	% aRfD	Exposure	% aRfD	Exposure	% aRfD
U.S. pop - all seasons:	0.006975	840.32	0.011522	1388.16	0.018360	2212.04
All infants (<1 year):	0.007954	958.30	0.013240	1595.12	0.019056	2295.90
Children (1-6 years):	0.012615	1519.89	0.018065	2176.53	0.024268	2923.91
Children (7-12 years):	0.009155	1103.02	0.013802	1662.90	0.017244	2077.61

RESIDUES AND PERCENT CROP TREATED DATA (FACTOR #2) FOR CHRONIC RISK ESTIMATES

CHEMICAL NAME: Disulfoton
RfD(CHRONIC): .000043 mg/kg/DAY NOEL(CHRONIC): .013000 mg/kg/day
Date created/last modified: 09-08-1998/09:03:51/8 Program ver. 6.16

Food Code	Crop Grp	Food Name	RESIDUE (ppm)		Adj. Factors #1	#2
260	A	ASPARAGUS	000.100000		01.000	00.530
265	O	BARLEY	000.200000		01.000	00.010
249	G	BEANS-DRY-BROADBEANS	000.750000		01.000	00.040
250	G	BEANS-SUCCULENT-BROADBEANS	000.750000		01.000	00.760
236	G	BEANS-SUCCULENT-YELLOW/WAX	000.750000		01.000	00.760
235	G	BEANS-SUCCULENT-OTHER	000.750000		01.000	00.760
234	G	BEANS-SUCCULENT-GREEN	000.750000		01.000	00.760
233	G	BEANS-SUCCULENT-LIMA	000.750000		01.000	00.760
232	G	BEANS-DRY-PINTO	000.750000		01.000	00.040
231	G	BEANS-DRY-OTHER	000.750000		01.000	00.040
251	G	BEANS-DRY-PIGEON BEANS	000.750000		01.000	00.040
230	G	BEANS-DRY-NAVY (PEA)	000.750000		01.000	00.040
229	G	BEANS-DRY-LIMA	000.750000		01.000	00.040
228	G	BEANS-DRY-KIDNEY	000.750000		01.000	00.040
227	G	BEANS-DRY-GREAT NORTHERN	000.750000		01.000	00.040
253	G	BEANS-UNSPECIFIED	000.750000		01.000	00.760
256	G	BEANS-DRY-HYACINTH	000.750000		01.000	00.040
257	G	BEANS-SUCCULENT-HYACINTH	000.750000		01.000	00.760
258	G	BEANS-DRY-BLACKEYE PEAS/COWPEA	000.750000		01.000	00.040
259	G	BEANS-DRY-GARBANZO/CHICK PEA	000.750000		01.000	00.040
324	U	BEEF-FAT W/O BONES	000.000170		01.000	01.000
325	U	BEEF-KIDNEY	000.001400		01.000	01.000
326	U	BEEF-LIVER	000.001400		01.000	01.000
327	U	BEEF-LEAN(FAT/FREE)W/O BONES	000.001400		01.000	01.000
322	U	BEEF-OTHER ORGAN MEATS	000.001400		01.000	01.000
323	U	BEEF-DRIED	000.001400		01.920	01.000
321	U	BEEF-MEAT BYPRODUCTS	000.001400		01.000	01.000
168	F	BROCCOLI	000.750000		01.000	00.210
169	F	BRUSSELS SPROUTS	000.750000		01.000	01.000
170	F	CABBAGE-GREEN AND RED	000.750000		01.000	00.090
173	F	CABBAGE-CHINESE/CELERY/BOK CHO	000.750000		01.000	00.090
171	F	CAULIFLOWER	000.750000		01.000	00.250
112	A	COFFEE	000.200000		01.000	01.000
172	F	COLLARDS	000.750000		01.000	00.090
237	O	CORN/POP	000.300000		01.000	01.000
267	O	CORN GRAIN-BRAN	000.300000		01.000	00.010
268	O	CORN GRAIN/SUGAR/HFCS	000.300000		01.500	00.010
266	O	CORN GRAIN-ENDOSPERM	000.300000		01.000	00.010
238	O	CORN/SWEET	000.300000		01.000	01.000
388	O	CORN GRAIN/SUGAR-MOLASSES	000.300000		01.500	00.010
289	O	CORN GRAIN-OIL	000.300000		01.000	00.010
290	A	COTTONSEED-OIL	000.750000		01.000	00.080
291	A	COTTONSEED-MEAL	000.750000		01.000	00.080
332	U	GOAT-LIVER	000.001400		01.000	01.000
329	U	GOAT-OTHER ORGAN MEATS	000.001400		01.000	01.000
333	U	GOAT-LEAN (FAT/FREE) W/O BONE	000.001400		01.000	01.000
331	U	GOAT-KIDNEY	000.001400		01.000	01.000
328	U	GOAT-MEAT BYPRODUCTS	000.001400		01.000	01.000
330	U	GOAT-FAT W/O BONE	000.000170		01.000	01.000
176	E	LETTUCE-LEAFY VARIETIES	002.000000		01.000	00.140
192	E	LETTUCE-HEAD VARIETIES	000.750000		01.000	00.140
182	E	LETTUCE-UNSPECIFIED	002.000000		01.000	00.140
319	X	MILK-FAT SOLIDS	000.000150		01.000	01.000
398	X	MILK-BASED WATER	000.000150		01.000	01.000
320	X	MILK SUGAR (LACTOSE)	000.000150		01.000	01.000
318	X	MILK-NONFAT SOLIDS	000.000150		01.000	01.000
399	O	OATS-BRAN	000.750000		01.000	00.040
269	O	OATS	000.750000		01.000	00.040
940	A	PEANUTS-HULLED	000.100000		01.000	00.060
293	A	PEANUTS-OIL	000.100000		01.000	00.060

403	A	PEANUTS-BUTTER	000.100000	01.890	00.060
241	G	PEAS (GARDEN)-GREEN	000.750000	01.000	00.040
240	G	PEAS (GARDEN)-DRY	000.750000	01.000	00.080
405	G	PEAS-SUCCUL./BLACKEYE/COWPEA	000.750000	01.000	00.040
047	R	PECANS	000.100000	01.000	00.040
156	I	PEPPERS-CHILLI INCL JALAPENO	000.100000	01.000	00.130
157	I	PEPPERS-OTHER	000.100000	01.000	00.130
155	I	PEPPERS-SWEET(GARDEN)	000.100000	01.000	00.130
158	I	PIMIENTOS	000.100000	01.000	00.130
347	U	PORK-LEAN (FAT FREE) W/O BONE	000.001400	01.000	01.000
346	U	PORK-LIVER	000.001400	01.000	01.000
345	U	PORK-KIDNEY	000.001400	01.000	01.000
344	U	PORK-FAT W/O BONE	000.000170	01.000	01.000
343	U	PORK- OTHER ORGAN MEATS	000.001400	01.000	01.000
342	U	PORK-MEAT BYPRODUCTS	000.001400	01.000	01.000
211	B	POTATOES/WHITE-PEEL ONLY	000.290000	01.000	00.080
208	B	POTATOES/WHITE-UNSPECIFIED	000.290000	01.000	00.080
207	B	POTATOES/WHITE-WHOLE	000.290000	01.000	00.080
209	B	POTATOES/WHITE-PEELED	000.290000	01.000	00.080
210	B	POTATOES/WHITE-DRY	000.290000	06.500	00.080
338	U	SHEEP-FAT W/O BONE	000.000170	01.000	01.000
337	U	SHEEP-OTHER ORGAN MEATS	000.001400	01.000	01.000
336	U	SHEEP-MEAT BYPRODUCTS	000.001400	01.000	01.000
339	U	SHEEP-KIDNEY	000.001400	01.000	01.000
340	U	SHEEP-LIVER	000.001400	01.000	01.000
341	U	SHEEP-LEAN (FAT FREE)W/O BONE	000.001400	01.000	01.000
275	O	SORGHUM (INCLUDING MILO)	000.750000	01.000	00.010
303	G	SOYBEAN-OTHER	000.100000	01.000	00.010
307	G	SOYBEANS-FLOUR (DEFATTED)	000.100000	01.000	00.010
305	G	SOYBEANS-FLOUR (FULL FAT)	000.100000	01.000	00.010
297	G	SOYBEANS-OIL	000.100000	01.000	00.010
304	G	SOYBEANS-MATURE SEEDS DRY	000.100000	01.000	00.010
306	G	SOYBEANS-FLOUR (LOW FAT)	000.100000	01.000	00.010
159	I	TOMATOES-WHOLE	000.750000	01.000	00.010
423	I	TOMATOES-DRIED	000.750000	14.300	00.010
160	I	TOMATOES-JUICE	000.750000	01.000	00.010
162	I	TOMATOES-PASTE	000.750000	01.000	00.010
163	I	TOMATOES-CATSUP	000.750000	01.000	00.010
161	I	TOMATOES-PUREE	000.750000	01.000	00.010
277	O	WHEAT-GERM	000.200000	01.000	00.010
278	O	WHEAT-BRAN	000.200000	01.000	00.010
279	O	WHEAT-FLOUR	000.200000	01.000	00.010
437	O	WHEAT-GERM OIL	000.200000	01.000	00.010
276	O	WHEAT-ROUGH	000.200000	01.000	00.010

CHRONIC RISK ESTIMATES

U.S. Environmental Protection Agency — Ver. 6.12
DEEM89N CHRONIC analysis for DISULFOTON — (1989-92 data)
Residue file name: 032501CR — Adjustment factor #2 used.
Analysis Date 10-29-1998 — Residue file dated: 09-08-1998/09:03:51/8
Reference dose (RfD, CHRONIC) = 0.000043 mg/kg body-wt/day

Total exposure by population subgroup

Population Subgroup	Total Exposure mg/kg body wt/day	Total Exposure Percent of Rfd
U.S. Pop - 48 states - all seasons	0.000278	647.5%
U.S. Population - spring season	0.000262	609.5%
U.S. Population - summer season	0.000281	654.0%
U.S. Population - autumn season	0.000277	643.4%
U.S. Population - winter season	0.000293	680.8%
Northeast region	0.000272	632.4%
Midwest region	0.000284	659.5%
Southern region	0.000297	690.6%
Western region	0.000248	575.7%
Pacific Region	0.000247	574.6%
Hispanics	0.000213	495.0%
Non-hispanic whites	0.000282	655.2%
Non-hispanic blacks	0.000306	712.4%
Non-hispanic other than black or white	0.000264	613.1%
All infants (<1 year)	0.000253	587.6%
Nursing infants (<1 year)	0.000035	80.4%
Non-nursing infants (<1 year)	0.000344	801.1%
Children (1-6 years)	0.000594	1,382.2%
Children (7-12 years)	0.000374	870.3%
Females (13-19 yrs/not preg. or nursing)	0.000214	498.0%
Females (20+ years/not preg. or nursing)	0.000238	554.2%
Females (13-50 years)	0.000220	511.9%
Females (13+/pregnant/not nursing)	0.000202	470.7%
Females (13+/nursing)	0.000274	637.3%
Males (13-19 years)	0.000237	550.2%
Males (20+ years)	0.000222	516.4%
Seniors (55+)	0.000259	602.0%

Critical Commodity Contribution Analysis for
U.S. Pop - 48 states - all seasons

Total Exposure = 0.0002784 mg/kg-body wt/DAY

Crop groups with total exposure contribution > 1%
Foods/Foodforms with exposure contribution > 1%

Crop group / Food / Foodform	Exposure Analysis: mg/kg body wt/day	% of Total Exposure	Percent of RfD
GROUP UNSPECIFIED			
COFFEE	0.0000052	1.85%	11.99%
Total for crop group	0.0000081	2.90%	18.75%
ROOT AND TUBER VEGETABLES			
POTATOES/WHITE-WHOLE	0.0000030	1.07%	6.96%
POTATOES/WHITE-PEELED	0.0000174	6.26%	40.52%
Total for crop group	0.0000217	7.79%	50.42%
LEAFY VEGETABLES (EXCL. BRASSICA VEG.)			
LETTUCE-HEAD VARIETIES	0.0000208	7.49%	48.49%
Total for crop group	0.0000225	8.07%	52.27%
BRASSICA (COLE) LEAFY VEGETABLES			
BROCCOLI	0.0000180	6.45%	41.76%
BRUSSELS SPROUTS	0.0000034	1.21%	7.82%
CABBAGE-GREEN AND RED	0.0000049	1.77%	11.44%
CAULIFLOWER	0.0000037	1.33%	8.62%
Total for crop group	0.0000308	11.07%	71.71%
LEGUME VEGETABLES (SUCCULENT OR DRIED)			
BEANS-SUCCULENT-LIMA	0.0000065	2.34%	15.15%
BEANS-SUCCULENT-GREEN	0.0000893	32.07%	207.67%
PEAS (GARDEN)-GREEN	0.0000035	1.26%	8.14%
Total for crop group	0.0001044	37.48%	242.71%
FRUITING VEGETABLES (EXCL. CUCURBITS)			
TOMATOES-WHOLE	0.0000031	1.12%	7.25%
Total for crop group	0.0000069	2.46%	15.94%

Critical Commodity Contribution Analysis for
All infants (<1 year)

Total Exposure = 0.0002527 mg/kg-body wt/DAY

Crop groups with total exposure contribution > 1%
Foods/Foodforms with exposure contribution > 1%

Crop group / Food / Foodform	Exposure Analysis: mg/kg body wt/day	% of Total Exposure	Percent of RfD
ROOT AND TUBER VEGETABLES			
POTATOES/WHITE-PEELED	0.0000069	2.75%	16.13%
POTATOES/WHITE-DRY	0.0000033	1.31%	7.68%
Total for crop group	0.0000105	4.15%	24.38%
BRASSICA (COLE) LEAFY VEGETABLES			
Total for crop group	0.0000032	1.26%	7.40%
LEGUME VEGETABLES (SUCCULENT OR DRIED)			
BEANS-SUCCULENT-LIMA	0.0000070	2.79%	16.38%
BEANS-SUCCULENT-GREEN	0.0001791	70.89%	416.53%
PEAS (GARDEN)-GREEN	0.0000071	2.83%	16.60%
Total for crop group	0.0001957	77.45%	455.08%
CEREAL GRAINS			
CORN/SWEET	0.0000187	7.42%	43.58%
CORN GRAIN/SUGAR/HFCS	0.0000047	1.87%	10.99%
OATS	0.0000123	4.86%	28.53%
Total for crop group	0.0000372	14.74%	86.60%
Total for crop groups listed above:	0.0002466	97.59%	573.46%

/OPP #

APPENDIX 4
Product Chemistry and Residue Chemistry Chapters for the Disulfoton RED

John Abbots

January 9, 1998

MEMORANDUM:

SUBJECT: Disulfoton (032501), Reregistration Case No. 0102. Product and Residue Chemistry Chapters for the Reregistration Eligibility Decision (RED). DP Barcode No. 240483, No MRID.

FROM: John Abbotts, Chemist
Chemistry and Exposure Branch I
Health Effects Division [7509C]

THRU: Francis B. Suhre, Branch Senior Scientist
Chemistry and Exposure Branch I
Health Effects Division [7509C]

TO: David Anderson
Reregistration Branch II
Health Effects Division [7509C]

and

Dana Lateulere
Reregistration Branch III
Special Review and Reregistration Division [7508W]

The Product and Residue Chemistry chapters for the Disulfoton RED are attached. The chapters were assembled by Dynamac Corporation under the supervision of CEBI, HED. The data assessment has undergone secondary review in the branch and has been revised to reflect Agency policies.

With regard to Product Chemistry, additional data are required for the 98.5% T pertaining to certified limits and enforcement analytical methods; data are also needed to meet the new requirement concerning UV/visible absorption (OPPTS GLN 830.7050). Additional data are required for the 68% and 2% FIs concerning enforcement analytical methods. Provided that the registrant submits the remaining required data, and either certifies that the suppliers of beginning materials and the manufacturing processes have not changed since the last comprehensive product chemistry review, or submits completed

updated product chemistry data packages, the Branch has no objections to the reregistration of Disulfoton with respect to product chemistry data requirements.

With regard to Residue Chemistry, plant metabolism remains an outstanding reregistration data requirement; until this requirement is satisfied, conclusions on all requirements for crop magnitude of the residue studies must be considered conditional. Reassessment of tolerances in Table C of the Residue Chemistry chapter is also conditional on satisfying the plant metabolism requirement. Field trial data remain outstanding for lettuce and cotton. For other crops, submitted field trial data are not entirely consistent with label use patterns, but data requirements may be satisfied by label amendments. Crops in this category include barley, cowpea forage and hay, field pea vines and hay, peanuts, sorghum, soybeans, tomatoes, wheat, and nonbearing fruit trees; further details are provided in the endnotes to Table B in the Residue Chemistry chapter. Data also remain outstanding for field rotational crops. For several crops not being supported for reregistration, data requirements will be waived provided tolerances are revoked.

Livestock feeding studies are satisfactory, up to feeding levels specified, and tolerances are recommended for ruminant commodities. Once the nature of the residue in plants is adequately understood and adequate magnitude of the residue data are available on all major feed items, this requirement will be reevaluated to determine if additional livestock feeding data are needed.

With regard to dietary exposure assessment, anticipated residues have been determined for chronic dietary risk (CBRS 10994, 17923, 9/17/97, J. Abbotts).

If additional information is required, please advise.

Attachment 1: Reregistration Eligibility Decision: Product Chemistry Considerations
Attachment 2: Reregistration Eligibility Decision: Residue Chemistry Considerations

cc(without Attachments):RF
cc(with Attachments): Abbotts, List A File
RDI:ResChemTeam:11/6/97:ChemSAC:1/7/98:FBSuhre:1/8/98
7509C:CEBI:JAbbotts:CM-2:Rm805B:305-6230:1/9/98
disulfot.red

DISULFOTON
Shaughnessy No. 032501; Case 0102

Reregistration Eligibility Decision: Product Chemistry Considerations

October 3, 1997

Contract No. 68-D4-0010

Submitted to:
U.S. Environmental Protection Agency
Arlington, VA

Submitted by:
Dynamac Corporation
The Dynamac Building
2275 Research Boulevard
Rockville, MD 20850-3268

DISULFOTON

REREGISTRATION ELIGIBILITY DECISION:

PRODUCT CHEMISTRY CONSIDERATIONS

Shaughnessy No. 032501; Case No. 0102

DESCRIPTION OF CHEMICAL

Disulfoton (O,O-diethyl S-[2-(ethylthio)ethyl] phosphorodithioate] is an acaricide and insecticide registered for use on vegetables, fruits, and cereal grains.

Empirical Formula:	$C_8H_{19}O_2PS_3$
Molecular Weight:	274.4
CAS Registry No.:	298-04-4
Shaughnessy No.:	032501

IDENTIFICATION OF ACTIVE INGREDIENT

Disulfoton is a colorless to yellow liquid with a boiling point of 62 C at 0.01 mm Hg. Disulfoton is soluble in water at 25 ppm at 20 C, and is miscible in dichloromethane, hexane, 2-propanol, and toluene at 20 C.

MANUFACTURING-USE PRODUCTS

A search of the Reference Files System (REFS) conducted 7/30/97 identified three disulfoton manufacturing-use products (MPs) registered under Shaughnessy No. 032501 to Bayer Corporation: the 98.5% technical (T; EPA Reg. No. 3125-183) and the 68% and 2% formulation intermediates (FIs; EPA Reg. Nos. 3125-158 and 3125-128, respectively). We note that REFS identifies the 2% FI as an end-use product; however, the label (dated 6/16/94) states that the product is for repackaging only. This product is correctly identified as an MP. Only the Bayer 98.5%, 68%, and 2% disulfoton MPs are subject to a reregistration eligibility decision.

REGULATORY BACKGROUND

The Disulfoton Reregistration Standard dated 4/6/84 required additional generic and product-specific product chemistry data for disulfoton MPs; however, the Disulfoton Guidance Document dated 12/84 required all updated product chemistry data. The Disulfoton Reregistration Standard Update dated 1/25/91 reviewed product chemistry data submitted in response to the Guidance Document and summarized the available database in support of the reregistration of disulfoton. Additional product chemistry data were required concerning GLNs 61-1, 61-2, 62-2, 62-3, 63-10, and 63-13 (OPPTS 830.1550, 830.1600-1650, 830.1750, 830.1800, 830.7370, and 830.6313) for the Bayer disulfoton MPs.

The current status of the product chemistry data requirements for the disulfoton MPs is presented in the attached data summary tables. These tables should be consulted for a listing of the outstanding product chemistry data requirements.

CONCLUSIONS

Most data requirements are satisfied for the 98.5% T; additional data are required pertaining to certified limits, enforcement analytical methods, and UV/visible absorption of the PAI (OPPTS 830.1750, 830.1800, and 830.7050). Additional data are required for the 68% and 2% FI concerning enforcement analytical methods (OPPTS 830.1800). Provided that the registrant submits the data required in the attached data summary tables for the 98.5% T and 68% and 2% FIs, and either certifies that the suppliers of beginning materials and the manufacturing processes for the disulfoton MPs have not changed since the last comprehensive product chemistry review or submits complete updated product chemistry data packages, CBRS has no objections to the reregistration of disulfoton with respect to product chemistry data requirements.

AGENCY MEMORANDA CITED IN THIS DOCUMENT

CBRS No(s).:	13169
DP Barcode(s):	D198930
Subject:	Disulfoton Reregistration. List A Chemical No. 032501; Case No. 0102. Miles Inc.: Response to Disulfoton Product Chemistry Data Requirements for Their 95% T/MP, 68% FI, and 2% FI Regarding GLN Nos. 61-1, 61-2, 61-3, 62-2, 62-3, 63-10, and 63-13.
From:	F. Toghrol
To:	L. Schnaubelt
Dated:	9/12/94
MRID(s):	43058601-43058606 and 43093601

CBRS No(s).:	14834
DP Barcode(s):	D210218
Subject:	Disulfoton Reregistration. Miles 12/9/94 Submission [Rebuttal of 62-2 & 62-3 Data Gaps for the 95% Technical: 3125-183] in Response to F. Toghrol 9/12/94 Review; CBRS 13169.
From:	K. Dockter
To:	P. Deschamp
Dated:	5/13/96
MRID(s):	None

PRODUCT CHEMISTRY CITATIONS

Bibliographic citations include only MRIDs containing data which fulfill data requirements.

References (cited):

00148493 Mobay Chemical Corp. (1985) Product Chemistry of Di-Syston Insecticide, Di-Syston 68% Concentrate, Di-Syston 2% Granular Systemic Insecticide, Di-Syston 2% Granular (Repackaging), Disyston 2% Systemic Insecticide Granules. Unpublished compilation. 47 p.

00150088 Mobay Chemical Corp. (1984) Product Chemistry of Di-Syston Insecticide. Unpublished compilation. 90 p.

43058601 Fontaine, L. (1993) Product Chemistry of DI-SYSTON Technical: Supplement to MRID 00150088: Lab Project Number: MCL0412: 011054: 101010. Unpublished study prepared by Miles Inc., Agriculture Division. 54 p.

43058602 Fontaine, L. (1993) Product Chemistry of DI-SYSTON Technical: Supplement to MRID 00150088: Lab Project Number: 86255: 106454: C-4.54. Unpublished study prepared by Miles Inc., Agriculture Division. 37 p.

43058603 Fontaine, L. (1993) Product Chemistry of DI-SYSTON 68% Concentrate: Supplement to MRID 00148493 and 00150088: Lab Project Number: 501835: PC0533: BR 1862. Unpublished study prepared by Miles Inc., Agriculture Division. 19 p.

43058604 Fontaine, L. (1993) Product Chemistry of DI-SYSTON 68% Concentrate: Supplement to MRID 00148492 and 00150088: Lab Project Number: 86767: BR 1863: PC0539. Unpublished study prepared by Miles Inc., Agriculture Division. 12 p.

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43058605 Fontaine, L. (1993) Product Chemistry of DI-SYSTON 2% Granular for Repackaging Use Only: Supplement to MRID 00148492 and 00150088: Lab Project Number: 401630: 301422: 301476. Unpublished study prepared by Miles Inc., Agriculture Division. 33 p.

43058606 Fontaine, L. (1993) Product Chemistry of DI-SYSTON 2% Granular for Repackaging Only: Supplement to MRID 00148493 and 00150088: Lab Project Number: 86766: PC0536: BR 1865. Unpublished study prepared by Miles Inc., Agriculture Division. 12 p.

43093601 Fontaine, L. (1993) Product Chemistry of DI-SYSTON Technical: Supplement to MRID 00148493 and 00150088: Lab Project Number: 91267: 95065: 95066. Unpublished study prepared by Miles Inc., Agriculture Division. 102 p.

Case No. 0102
Chemical No. 032501

Case Name: Disulfoton
Registrant: Bayer Corporation
Product(s): 98.5% T (EPA Reg. No. 3125-183)

PRODUCT CHEMISTRY DATA SUMMARY

Guideline Number	Requirement	Are Data Requirements Fulfilled? [1]	MRID Number [2]
830.1550	Product Identity and Disclosure of Ingredients	Y	**00150088**, 43058601, 43058602
830.1600	Starting Materials and Manufacturing Process	Y	**00150088**, 43058601
830.1620			
830.1650			
830.1670	Discussion of Formation of Impurities	Y	**00148493**, 43058601
830.1700	Preliminary Analysis	Y	**00150088**, 43058602
830.1750	Certification of Ingredient Limits	N [3]	**00148493**, 43058602
830.1800	Analytical Methods to Verify the Certified Limits	N [4]	**00148493**, **00150088**, 43058602
830.6302	Color	Y	**00150088**
830.6303	Physical State	Y	**00150088**
830.6304	Odor	Y	**00150088**
830.6313	Stability	Y	**00150088**, 43093601
830.6314	Oxidation/Reduction	Y	**00148493**
830.6315	Flammability	Y	**00150088**
830.6316	Explodability	Y	**00150088**
830.6317	Storage Stability	Y	**00148493**
830.6319	Miscibility	N/A [5]	**00150088**
830.6320	Corrosion Characteristics	Y	**00148493**
830.7000	pH	Y	**00150088**
830.7050	UV/Visible Absorption	N [6]	
830.7100	Viscosity	Y	**00148493**
830.7200	Melting Point/Melting Range	N/A [7]	
830.7220	Boiling Point/Boiling Range	Y	**00148493**
830.7300	Density/Relative Density/Bulk Density	Y	**00148493**, **00150088**
830.7370	Dissociation Constant in Water	Y	43093601
830.7550	Partition Coefficient (Octanol/Water)	Y	**00148493**
830.7560			
830.7570			
830.7840	Solubility	Y	**00150088**
830.7860			
830.7950	Vapor Pressure	Y	**00148493**, **00150088**

[1] Y = Yes; N = No; N/A = Not Applicable.

[2] **Bolded** references were reviewed in the Disulfoton Reregistration Standard Update dated 1.25/91, and all other references were reviewed under CBRS No. 13169, D198930, 9/12.94, F. Toghrol.

[3] Upper certified limits for impurities structurally related to the active ingredient and present at greater than 0.1%, and for an EPA List 2 potentially toxic inert must be provided on an amended CSF. The Agency has addressed the registrant's claim that these impurities are not toxicologically significant (CBRS No. 14834, D210218, 5/13/96, K. Dockter), and requires that the registrant submit data which demonstrate that all the impurities are not toxicologically significant or a revised CSF with upper certified limits for all impurities quantitated in preliminary analysis.

[4] Additional validation data must be submitted for the methods used to determine the active ingredient and impurities present at greater than 0.1%. The Agency has addressed the registrant's claim that these impurities are not of toxicological significance (CBRS No. 14834, D210218, 5/13/96, K. Dockter), and requires validation data for the active ingredient and all impurities quantitated.

[5] Data are not required because the product is not typically diluted with petroleum solvents.

[6] The OPPTS Series 830, Product Properties Test Guidelines require data pertaining to UV/visible absorption for the PAI.

[7] Data are not required because the TGAI/MP is a liquid at room temperature.

Case No. 0102
Chemical No. 032501

Case Name: Disulfoton
Registrant: Bayer Corporation
Product(s): 68% FI (EPA Reg. No. 3125-158)

PRODUCT CHEMISTRY DATA SUMMARY

Guideline Number	Requirement	Are Data Requirements Fulfilled? [1]	MRID Number [2]
830.1550	Product Identity and Disclosure of Ingredients	Y [3]	**00150088**, 43058603, 43058604
830.1600	Starting Materials and Manufacturing Process	Y	**00150088**, 43058603
830.1620			
830.1650			
830.1670	Discussion of Formation of Impurities	Y	**00150088**
830.1700	Preliminary Analysis	N/A [4]	
830.1750	Certification of Ingredient Limits	Y	**00148493**, 43058604
830.1800	Analytical Methods to Verify the Certified Limits	N [5]	**00148493**, **00150088**
830.6302	Color	Y	**00150088**
830.6303	Physical State	Y	**00150088**
830.6304	Odor	Y	**00150088**
830.6313	Stability	N/A [4]	
830.6314	Oxidation/Reduction	Y	**00150088**
830.6315	Flammability	Y	**00150088**
830.6316	Explodability	Y	**00150088**
830.6317	Storage Stability	Y	**00150088**
830.6319	Miscibility	N/A [6]	**00150088**
830.6320	Corrosion Characteristics	Y	**00150088**
830.7000	pH	N/A [7]	
830.7050	UV/Visible Absorption	N/A [4]	
830.7100	Viscosity	Y	**00150088**
830.7200	Melting Point/Melting Range	N/A [4]	
830.7220	Boiling Point/Boiling Range	N/A [4]	
830.7300	Density/Relative Density/Bulk Density	Y	**00150088**
830.7370	Dissociation Constant in Water	N/A [4]	
830.7550	Partition Coefficient (Octanol/Water)	N/A [4]	
830.7560			
830.7570			
830.7840	Solubility	N/A [4]	
830.7860			
830.7950	Vapor Pressure	N/A [4]	

[1] Y = Yes; N = No; N/A = Not Applicable.

[2] **Bolded** references were reviewed in the Disulfoton Reregistration Standard Update dated 1/25/91, and all other references were reviewed under CBRS No. 13169, D198930, 9/12/94, F. Toghrol.

[3] We note that the source of an inert ingredient was not listed on the CSF.

[4] TGAI PAI data requirements will be satisfied by data for the technical source product.

[5] Additional validation data are required for the method used to quantitate the active ingredient in this formulation (CBRS No. 13169, D198930, 9/12/94, F. Toghrol).

[6] Data are not required because the product is not typically diluted with petroleum solvents.

[7] Data are not required because the MP is practically insoluble in water.

Case No. 0102
Chemical No. 032501

Case Name: Disulfoton
Registrant: Bayer Corporation
Product(s): 2% FI (EPA Reg. No. 3125-128) basic and alternate formulations

PRODUCT CHEMISTRY DATA SUMMARY

Guideline Number	Requirement	Are Data Requirements Fulfilled? [1]	MRID Number [2]
830.1550	Product Identity and Disclosure of Ingredients	Y [3]	00150088, 43058605, 43058606
830.1600 830.1620 830.1650	Starting Materials and Manufacturing Process	Y	00150088, 43058605, 43058606
830.1670	Discussion of Formation of Impurities	Y	00150088
830.1700	Preliminary Analysis	N/A [4]	
830.1750	Certification of Ingredient Limits	Y	00148493, 43058605, 43058606
830.1800	Analytical Methods to Verify the Certified Limits	N [5]	00148493, 00150088
830.6302	Color	Y	00150088
830.6303	Physical State	Y	00150088
830.6304	Odor	Y	00150088
830.6313	Stability	N/A [4]	
830.6314	Oxidation/Reduction	Y	00150088
830.6315	Flammability	N/A [6]	
830.6316	Explodability	Y	00150088
830.6317	Storage Stability	Y	00150088
830.6319	Miscibility	N/A [6]	
830.6320	Corrosion Characteristics	Y	00150088
830.7000	pH	N/A [7]	
830.7050	UV/Visible Absorption	N/A [4]	
830.7100	Viscosity	N/A [6]	
830.7200	Melting Point/Melting Range	N/A [4]	
830.7220	Boiling Point/Boiling Range	N/A [4]	
830.7300	Density/Relative Density/Bulk Density	Y	00150088
830.7370	Dissociation Constant in Water	N/A [4]	
830.7550 830.7560 830.7570	Partition Coefficient (Octanol/Water)	N/A [4]	
830.7840 830.7860	Solubility	N/A [4]	
830.7950	Vapor Pressure	N/A [4]	

[1] Y = Yes; N = No; N/A = Not Applicable.

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[2] **Bolded** references were reviewed in the Disulfoton Reregistration Standard Update dated 1 25 91, and all other references were reviewed under CBRS No. 13169, D198930, 9/12/94, F. Toghrol.

[3] We note that the sources of the inert ingredients were not listed on the CSFs for the basic and alternate formulations.

[4] TGAI/PAI data requirements will be satisfied by data for the technical source product.

[5] Additional validation data are required for the method used to quantitate the active ingredient in this formulation (CBRS No. 13169, D198930, 9/12/94, F. Toghrol).

[6] Data are not required because the MP is a solid at room temperature.

[7] Data are not required because the MP is practically insoluble in water.

DISULFOTON
Shaughnessy No. 032501; Case 0102

Reregistration Eligibility Decision: Residue Chemistry Considerations

October 3, 1997

Contract No. 68-D4-0010

Submitted to:
U.S. Environmental Protection Agency
Arlington, VA

Submitted by:
Dynamac Corporation
The Dynamac Building
2275 Research Boulevard
Rockville, MD 20850-3268

DISULFOTON

REREGISTRATION ELIGIBILITY DECISION

RESIDUE CHEMISTRY CONSIDERATIONS

Shaughnessy No. 032501; Case 0102

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DISULFOTON

REREGISTRATION ELIGIBILITY DECISION

RESIDUE CHEMISTRY CONSIDERATIONS

Shaughnessy No. 032501; Case 0102

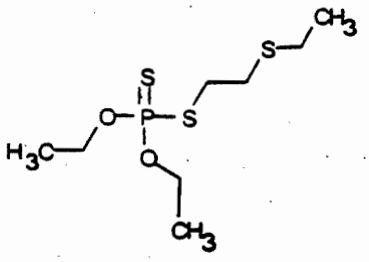
INTRODUCTION

Disulfoton (O,O-diethyl S-[2-(ethylthio)ethyl] phosphorodithioate) is an acaricide and insecticide registered by Bayer Corporation under the trade name Di-Syston®. Disulfoton is currently registered for preplant, at-planting, preemergence; and foliar applications to asparagus, barley, beans, Bermuda grass (grown for seed), broccoli, Brussels sprouts, cabbage, cauliflower, coffee, corn (field, pop, and sweet), cotton, lentils, lettuce, oats, peanuts, peas, pecans, peppers, potatoes, sorghum, soybeans, tobacco, tomatoes, triticale, and wheat. In general, applications may be made with either ground or aerial equipment. The 2% and 15% granular (G), 95% ready-to-use (RTU), and 8 lb/gal emulsifiable concentrate (EC) formulations are the disulfoton formulation classes registered for use on food/feed crops.

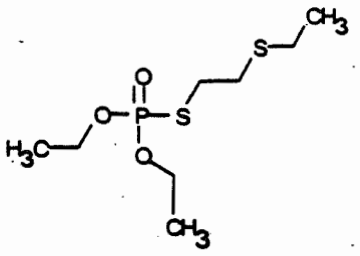
REGULATORY BACKGROUND

Disulfoton is a List A FIFRA reregistration chemical and was the subject of a Reregistration Standard Guidance Document dated 12/84. The Residue Chemistry Chapter of the Guidance Document was completed on 4/6/84. The Residue Chemistry Chapter Update of the Disulfoton Reregistration Standard was issued on 1/25/91. These documents summarized the regulatory conclusions based on available residue chemistry data, and specified the additional data required for reregistration purposes. Several data submissions have been received and evaluated since the Update. The information contained in this document outlines the Residue Chemistry Science Assessments with respect to the reregistration of disulfoton.

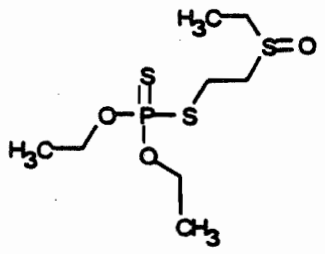
Tolerances are established for the combined residues of disulfoton and its cholinesterase-inhibiting metabolites, calculated as demeton, in/on various raw agricultural plant commodities [40 CFR §180.183(a) and (b)]. Tolerances are established for residues of disulfoton *per se*, calculated as demeton, in processed feed commodities [40 CFR §186.1950]. The chemical structures of identified tolerance residues are presented in Figure 1; full chemical names are listed in Table A. Adequate methods are available for the enforcement of tolerances for plant commodities.



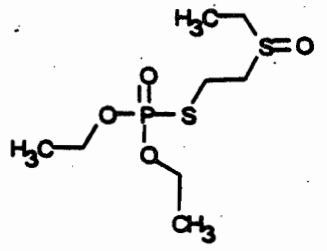
I. Disulfoton



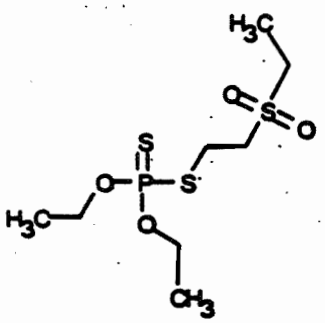
IV. Disulfoton oxygen analog; Demeton-S



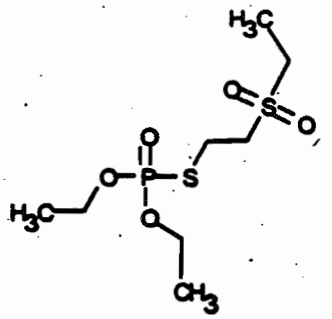
II. Disulfoton sulfoxide



V. Disulfoton oxygen analog sulfoxide



III. Disulfoton sulfone



VI. Disulfoton oxygen analog sulfone

Figure 1. Identified Disulfoton tolerance residues.

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Table A. Chemical Names of Identified Disulfoton Tolerance Residues (Structures in Figure 1).

Common Name Chemical Name	Common Name Chemical Name
I. Disulfoton O,O-diethyl S-[2-(ethylthio)ethyl]phosphorodithioate	**IV. Disulfoton oxygen analog; Demeton-S** O,O-diethyl S-[2-(ethylthio)-ethyl]phosphorothioate
II. Disulfoton sulfoxide O,O-diethyl S-[2-(ethylsulfinyl)ethyl]phosphorodithioate	**V. Disulfoton oxygen analog sulfoxide** O,O-diethyl S-[2-(ethylsulfinyl)-ethyl]phosphorothioate
III. Disulfoton sulfone O,O-diethyl S-[2-(ethylsulfonyl)ethyl]-phosphorodithioate	**VI. Disulfoton oxygen analog sulfone** O,O-diethyl S-[2-(ethylsulfonyl)-ethyl]phosphorothioate

The Food Quality Protection Act (FQPA) of 1996 has amended and strengthened the standard for establishing tolerances under the Federal Food, Drug, and Cosmetic Act (FFDCA). The Office of Pesticide Programs is still assessing the full impact of this change in the law, and plans to issue guidelines concerning the establishment and reassessment of tolerances under the amended statute. All future tolerance petitions as well as reassessment of established tolerances must meet the requirements of the FFDCA as amended by the FQPA. The Office of Pesticide Programs (OPP) may require additional data to determine if the terms of the amended statute are met. The information contained in this document outlines the Residue Chemistry Science Assessments with respect to the reregistration of disulfoton.

SUMMARY OF SCIENCE FINDINGS

GLN 860.1200: Directions for Use

The basic producer of disulfoton is Bayer Corporation (formerly Miles, Inc.), and the majority of residue chemistry data in support of reregistration have been submitted by Bayer. According to a REFS search, conducted on 7/30/97, there are five active Bayer end-use products (EPs) containing the active ingredient disulfoton which are registered for use on food/feed crops. These EPs, including the associated Special Local Need (SLN) registrations under FIFRA Section 24(c), are listed in Table A1.

Table A1 Disulfoton EPs with Food/Feed Uses Registered to Bayer Corporation.

EPA Reg. No.	Label Acceptance Date [1]	Formulation	Product Name
3125-83 [2]	6/1 95	2% G	DI-SYSTON® 2% Granular Systemic Insecticide
3125-126 [2]	4/25/94	2% G	DI-SYSTON® Systemic Insecticide For Vegetables
3125-172 [3]	8/11/95	15% G	DI-SYSTON® 15% Granular Systemic Insecticide
3125-173	10/31/89	95% RTU	DI-SYSTON® Seed Treatment Insecticide
3125-307 [4]	10/13/94	8 lb/gal EC	DI-SYSTON® 8

[1] Date of the most recently EPA-approved label found by reviewer in the product jacket or Pesticide Product Label System (PPLS).
[2] This product is for homeowner use only.
[3] Including SLN Nos. CA760019, ID830035, ID850016, MT800004, NC920011, OR790042 (on order), OR800034, OR830057, VA920006, and WA850036.
[4] Including SLN Nos. AZ850007, CA770036, CA810044, CA840192, CA920025, CA960014, ME880001, NC860005, NM880001, OK880002, OR840032, TX860007, TX900004, WA840036, and WY870004.

A comprehensive summary of disulfoton food/feed use patterns, based on the product labels registered to Bayer, is presented in Table A2. A tabular summary of the residue chemistry science assessments for reregistration of disulfoton is presented in Table B. The status of reregistration requirements for each guideline topic listed in Table B are based on the use patterns registered by the basic producer.

Non-food uses of disulfoton: A list of disulfoton non-food/non-feed use patterns, based on the product labels registered to Bayer, is presented below. The registered uses of disulfoton on the following sites, typically considered food use sites, have been determined to be non-food uses based on an examination of the product labels: nonbearing fruits, raspberries (nursery stock), radish excluding daikon (seed crop), and strawberries (propagating plants). As a result of the non-food use classification, residue chemistry data are not required and tolerances need not be proposed for the reregistration of these uses.

Nonbearing fruits (including apples, apricots, cherries, crabapples, peaches, pears, plums, and prunes): The 15% G (EPA Reg. No. 3125-172) formulation is registered for use as a soil application at 0.024-0.234 lb ai/tree or 0.375 oz ai/inch of trunk diameter. Application is made uniformly on all sides from the trunk to drip line and is followed by soil incorporation. Application to trees bearing fruit during that crop year is prohibited.

The Residue Chemistry Chapter (4/6/84) designated this use as non-food. However, current guidelines (OPPTS Test Guidelines, Residue Chemistry, 860.1000, August 1996) require that for pesticides not known to be persistent and systemic (criteria which disulfoton satisfies), a label restriction against harvesting within one year of application is required for a use to be declared nonfood. Such a restriction is required for this use on fruit trees.

Radish excluding daikon (seed crop): The 15% G (SLN No. WA920027) and the 8 lb/gal EC (SLN No. WA920026) formulations are registered for use as a single soil injection application at first seed stalk bolting at 1.5-2.0 lb ai/A. Use is limited to eastern WA. The feeding or grazing of radish forage or fodder is prohibited. The cutting of radish tops for hay or forage is prohibited. The use of any portion of the treated field, including seed, seed screening, hay, forage, or stubble for human or animal consumption is prohibited.

Raspberries (nursery stock): The 15% G (EPA Reg. No. 3125-172) formulation is registered for use for two banded soil incorporated applications at 8.0 lb ai/A/application. Use is limited to Northeast states. Application is allowed at planting and "later in the season."

Strawberries (propagating plants only): The 15% G (EPA Reg. No. 3125-172) formulation is registered for use as a soil broadcast or sidedress application at 2.6-5.2 oz ai/1,000 ft of row (for any row spacing) or 2.0-4.0 lb ai/A (42-inch row spacing). The 8 lb/gal EC (EPA Reg. No. 3125-307) formulation is registered for use as a soil injection application at 2.8-5.0 oz ai/1.000 ft of row (for any row spacing) or 2.0-4.0 lb ai/A (42-inch row spacing). Use of fruit from treated plants for food purposes is prohibited..

For the purpose of generating this Residue Chemistry Science Chapter, the Chemistry Branch examined the registered food/feed use patterns of the basic producer and reevaluated the available residue chemistry database for adequacy in supporting these use patterns. When end-use product DCIs are developed (e.g., at issuance of the RED), RD should require that all end-use product labels (e.g., MAI labels, SLNs, and products subject to the generic data exemption) be amended such that they are consistent with the basic producer labels.

Label amendments are also required to incorporate the parameters of use patterns reflected in the submitted field trials. Details of the required label amendments are presented in the endnote for GLN 860.1200 (Directions for Use) and in the endnotes for specific crops under GLN 860.1500 in Table B.

GLN 860.1300: Nature of the Residue - Plants

The reregistration requirements for plant metabolism are not fulfilled. Additional information is required to upgrade existing studies with lettuce, potatoes, soybeans, and wheat. In the interim, the HED Metabolism Committee has determined that residues to be regulated in plant commodities are disulfoton, disulfoton oxygen analog, and their sulfoxides and sulfones (see Figure 1). The Committee also determined that demonstration by the registrant that significant unknown disulfoton metabolites in plants do not contain phosphorus would be sufficient for waiving regulatory concern over those unknowns.

GLN 860.1300: Nature of the Residue - Livestock

The reregistration requirements for livestock metabolism are fulfilled. Acceptable studies depicting the qualitative nature of the residue in ruminants and poultry have been submitted and evaluated. Disulfoton and its sulfonic acid metabolites were the major detected residues. The HED Metabolism Committee has determined that the sulfonic acid metabolites need not be included in the tolerance expression for livestock commodities and that residue data for sulfonic acid metabolites in livestock commodities are not required. The residues of concern in livestock commodities are disulfoton and its cholinesterase-inhibiting metabolites.

GLN 860.1340: Residue Analytical Methods

Adequate methods are available for data collection and tolerance enforcement for plant and livestock commodities. The Pesticide Analytical Manual (PAM) Vol. II lists the enforcement methods for demeton, paper chromatography and colorimetric methods, as Method I. A GC method (Method II) with potassium chloride thermionic detection is listed for the determination of disulfoton, its oxygen analog, and their sulfoxides and sulfones in/on plant commodities. This method involves oxidation of disulfoton and its sulfoxide to disulfoton sulfone and oxidation of disulfoton oxygen analog and its sulfoxide to disulfoton oxygen analog sulfone. Methods used for data collection for plant commodities include GC methods similar to Method II of PAM Vol. II, total phosphorus methods similar to the demeton colorimetric method listed as Method II of PAM, and methods based on cholinesterase-inhibition. Methods used for data collection for livestock commodities include GC methods similar to Method II of PAM II; the method limit of quantitation (LOQ) is
0.05 ppm in meat and 0.01 ppm in milk (D241353, 12/15/97, J. Abbotts).

We note that the GC method in PAM calculates residues in terms of disulfoton whereas the tolerance expression states that residues are calculated as demeton. The majority of data used for tolerance reassessment were collected using the enforcement GC method (or modification thereof). Therefore, the tolerance expression should be revised to state that residues are to be calculated as disulfoton. This revision will also make the tolerance expression compatible with the Codex expression.

Plant metabolism data remain outstanding. If additional plant metabolites which require regulation are identified, then additional analytical methodology for these metabolites will be required.

GLN 860.1360: Multiresidue Methods

The 2/97 FDA PESTDATA database (PAM Volume I, Appendix I) indicates that disulfoton, its sulfoxide and sulfone, demeton-S (disulfoton oxygen analog), and its sulfoxide and sulfone

are completely recovered (>80%) using Multiresidue Method Section 302 (Luke Method; Protocol D). Disulfoton is partially recovered (50-74%) and metabolites disulfoton sulfone and demeton-S are not recovered using Multiresidue Method Section 303 (Mills, Onley, Gaither Method; Protocol E, non-fatty foods). Disulfoton is not recovered using Section 304 (Mills Method; Protocol E, fatty foods).

GLN 860.1380: Storage Stability Data

The reregistration requirements for storage stability data are partially fulfilled. Storage stability data for livestock commodities will be required to support available and/or new livestock feeding studies unless samples are stored less than one month prior to analysis.

The available storage stability data indicate that residues of disulfoton and its sulfoxide and sulfone are stable under frozen storage conditions for up to 13 months in potato chips and flakes, 24 months in/on potato wet peel and tomatoes, and for up to 36 months in/on alfalfa forage and hay; broccoli; coffee beans (dry); corn (sweet); cottonseed; lettuce; peanut meal, oil, and soapstock; peas (green); potato tubers; sorghum grain; strawberries; tobacco (cured); tomato catsup, juice, and dry pomace; and wheat grain, forage, straw, bran, flour, and shorts. Residues of disulfoton oxygen analog and its sulfoxide and sulfone are stable for up to 13 months in potato chips and flakes, 24 months in/on potato wet peel and sorghum grain, and for up to 36 months in/on alfalfa forage and hay; broccoli; coffee beans (dry); corn (sweet); cottonseed; lettuce; peanut meal and oil; peas; potato tubers; strawberries; tobacco (cured); tomatoes and tomato catsup, juice, and dry pomace; and wheat grain, forage, straw, bran, flour, and shorts. The matrices chosen in the storage stability study are representative of the raw agricultural and processed commodities resulting from registered uses of disulfoton. These storage stability data have been compared with storage intervals and conditions for available field trial and processing data; for those crops that have been evaluated, the storage stabilty data are sufficient to support the magnitude of the residue studies (CBRS 17896, 6/18/97, J. Abbotts).

GLN 860.1500: Crop Field Trials

The reregistration requirements for magnitude of the residue in/on the following RACs will be considered fulfilled pending label revisions and/or tolerance adjustments: asparagus; barley, grain and straw; beans (succulent and dry); broccoli; Brussels sprouts; cabbage; cauliflower; coffee, beans; corn, field, forage, grain, and stover; corn, pop, grain and stover; corn, sweet (K+CWHR) and sweet corn forage and stover; cotton, seed; oats, forage, grain, and straw; peanuts, hay and nutmeats; peas (succulent and dry); pecans; peppers; potatoes; sorghum, forage, grain, and stover; soybeans, forage, hay, and seed; tomatoes; and wheat, forage, grain, and straw. Overall, adequate field trial data depicting disulfoton residues of concern following treatments according to the maximum registered use patterns have been submitted for the

RACs listed above. Label revisions are required for some crops in order to reflect current Agency policies and/or to reflect the parameters of use patterns for which field trial data are available. Refer to the "Tolerance Reassessment Summary" for recommendations regarding appropriate tolerance levels.

In addition, current guidelines (OPPTS Test Guidelines, Residue Chemistry, August 1996, 860.1000, Table 1) distinguish between grain sorghum and forage sorghum. The latter commodity falls under the grass category. To avoid additional data requirements on grasses, labels should be modified to limit use on grain sorghum only.

Moreover, Table A2 below includes postemergence use on soybeans grown for seed, with no PHI but a label restriction prohibiting soybeans grown for seed from being used for food, feed, or forage. The Residue Chemistry Chapter (4/6/84) advised that soybean seed was a raw agricultural commodity which could be diverted to human and livestock consumption. Accordingly, the Chapter recommended for postemergence application either the establishment of a 125 PHI, or restricting application to at-planting only. Under current residue chemistry Guidelines (OPPTS 860.1000), label restrictions against feeding soybean forage and hay are allowed, but restrictions on feeding seed are considered impractical. The label restrictions recommended by the Residue Chemistry Chapter therefore remain appropriate, with the additional requirement that the label limit application to one per growing season. If the registrant desires label conditions different from these limits for soybeans grown for seed, additional field trial data may be necessary.

Additional field trial data must be submitted before the reregistration requirements for magnitude of the residue in/on the following RACs will be fulfilled: cowpea forage and hay, field pea vines and hay, and lettuce. The registrant may choose to amend product labels to exclude use of disulfoton on cowpeas and field peas instead of submitting field trial data. As a result of changes in Table 1 (GLN 860.1000), field residue data are additionally now required for cotton gin byproducts. Tolerances should also be proposed for oat hay, based on data for wheat hay.

Adequate magnitude of the residue data are available for the aspirated grain fractions of corn, sorghum, and wheat. These data indicate that a tolerance for aspirated grain fractions is required. Data for soybean aspirated grain fractions are not required as use of disulfoton on soybeans is early in the growing season, and processing data indicate that soybean surface residues are not likely to be greater than residues in or on whole seed.

The registrant currently has no registered uses of disulfoton on alfalfa, clover, hops, pineapple, rice, spinach, sugar beets, and sugarcane. Provided tolerances are revoked for these crops, no additional field trial data are required. Because no field trial data are available, use on Bermuda grass grown for seed must be canceled.

An acceptable tobacco pyrolysis study has been submitted and evaluated.

GLN 860.1520: Processed Food/Feed

The reregistration requirements for magnitude of the residue in the processed commodities of the following crops have been fulfilled: coffee, field corn, cottonseed, peanuts, potatoes, soybeans, tomatoes, and wheat. Processing data for wheat may be translated to barley and oats.

Disulfoton residues of concern concentrated in wet potato peel (1.71x), in tomato paste (1.7x), and in wheat germ (2.12x). Based on a highest average field trial (HAFT) value for potatoes of 0.17 ppm, the expected residues in wet potato peel are 0.29 ppm, which is less than the reassessed tolerance of 0.50 ppm for potatoes. Based on a HAFT of 0.03 ppm, the expected residues in wheat germ are 0.06 ppm, which is less than the reassessed tolerance of 0.2 ppm for wheat grain. Based on a HAFT of 0.36 ppm, expected residues in tomato paste are 0.61 ppm, less than the reassessed tolerance of 0.75 ppm for tomatoes.

Residue data for sweet sorghum syrup must be submitted unless the registrant modifies product labels to exclude use on sweet sorghum.

The registrant currently has no registered uses of disulfoton on pineapple, rice, and sugarcane. Provided tolerances are revoked for these crops, no additional processing data are required.

GLN 860.1480: Meat, Milk, Poultry, and Eggs

Reregistration requirements for magnitude of the residue in meat, milk, poultry, and eggs are satisfied, up to the feeding levels in the studies described below (D241353, 12/15/97, J. Abbotts). Data remain outstanding on some feed items, so this requirement will be reevaluated once the nature of the residue in plants is adequately understood and magnitude of the residue data are available for all major feed items.

Milk and the fat, meat, and meat byproducts of cattle, goats, hogs, horses, and sheep: The maximum theoretical dietary burdens of disulfoton to beef and dairy cattle are 7.0 and 8.2 ppm, respectively (see table below).

Calculation of maximum ruminant dietary burden for disulfoton.

Feed Commodity	Reassessed Tolerance (ppm)	% Dry Matter	Beef Cattle		Dairy Cattle	
			% of Diet	Burden (ppm)	% of Diet	Burden (ppm)
Cotton, seed	0.75	88	25	0.21	25	0.21
Potato, processed waste	0.5	15	35	1.17	25	0.83
Sorghum, forage	5.0	35	40	5.71	50	7.14
		TOTAL	100	7.09	100	8.18

Available dairy cattle feeding data have been reviewed, at feeding levels of 3.6 and 7.2 ppm, and 18 ppm for milk only (D241353, 12/15/97, J. Abbotts). Maximum residues were 0.03 ppm in tissue, and 0.012 ppm in milk. Based on the maximum burdens in the Table above, appropriate tolerance values would be 0.05 ppm in ruminant meat commodities, and 0.01 ppm in milk.

Eggs and the fat, meat, and meat byproducts of poultry: The maximum theoretical dietary burden of disulfoton to poultry is calculated to be 0.87 ppm based on a diet consisting of 20% cottonseed meal and 80% sorghum grain. Available poultry feeding data have been reviewed, at feeding levels of 12 and 36 ppm (D241353, 12/15/97, J. Abbotts). In eggs, detectable levels up to 0.002 ppm, which were still below the method LOQ, were found in samples from two birds at the 36 ppm feeding level. In tissues, detectable residues were found at 0.02 ppm in one giblet sample from the 36 ppm level. Residues were nondetectable in all other samples from the 36 ppm feedng level, and in all samples from the 12 ppm group. Initial review of these data concluded that poultry commodities represented a Section 180.6(a)(3) category, and tolerances were not required for poultry and eggs
(PP 7F1895, 6/27/77, M.J. Nelson). The feeding levels represent 14x and 41x the current maximum dietary burden, respectively, and the conclusion that tolerances are not required for poultry commodities remains appropriate.

GLN 860.1400: Water, Fish, and Irrigated Crops

Disulfoton is presently not registered for direct use on water and aquatic food and feed crops. In addition, the registrant is not supporting use of disulfoton on rice. Provided tolerances on rice are revoked, no residue chemistry data are required under this guideline topic.

GLN 860.1460: Food Handling

Disulfoton is presently not registered for use in food-handling establishments; therefore, no residue chemistry data are required under this guideline topic.

GLNs 860.1850 and 860.1900: Confined/Field Accumulation in Rotational Crops

The reregistration requirements for confined accumulation in rotational crops are satisfied, and limited field rotational crop studies have been conducted. Provided the residues to be regulated in plants do not change under reregistration, rotational tolerance requirements can be waived for cereal grains at any plantback interval and for leafy vegetables at a plantback interval of at least 240 days. Extensive field rotational crop trials must be conducted for all crops, other than primary crops, for which rotation is desired. The Agency would not object if the registrant delayed initiation of additional rotational crop trials until determination of the residues to be regulated in plant commodities, provided additional data on primary plant metabolism are submitted in a timely manner. We note that there are currently no rotational crop restrictions on disulfoton end-use product labels.

Table A2. Food/Feed Use Patterns Subject to Reregistration for Disulfoton (Case 0102).

Site Application Timing Application Type Application Equipment	Formulation [EPA Reg. No.]	Single Application Rate, ai	Maximum Number of Applications Per Season	Maximum Seasonal Rate, ai	Preharvest Interval, Days	Use Limitations [1]
Asparagus						
Foliar application postharvest (fern stage) Ground or aerial	8 lb/gal EC [AZ850007] [WA840036]	1.0 lb/A	3	Not specified (NS)	45	Use limited to AZ, CA, NC, OR, and WA. Applications may be made in a minimum of 20 gal/A (ground) or 5 gal/A (aerial).
	8 lb/gal EC [CA840192]	1.0 lb/A	3	NS	30	
	8 lb/gal EC [NC860005]	1.0 lb/A	3	NS	120	
	8 lb/gal EC [OR840032]	1.0 lb/A	3	NS	180	
Barley						
At-planting Drill or broadcast soil or Postemergence Broadcast soil Ground	15% G [3125-172]	1.0 lb/A	2	NS	60 (grain) 30 (forage)	Applications may be repeated at a 21 day interval. A 30-day pregrazing interval (PGI) has been established.
At-planting Drill or broadcast soil Ground	15% G [ID850016] [OR800034] [WA850036]	1.0 lb/A	1	NS	75 (forage)	Use limited to ID, OR, and WA. A 75-day PGI has been established. Straw from harvested fields may be baled and used for feed.
	15% G [MT800004]	1.0 lb/A	1	NS	60	Use limited to MT. A 60-day PGI has been established. Straw from harvested fields may be baled and used for feed.
At-planting Soil injection Ground	8 lb/gal EC [3125-307]	0.25 oz/1,000 ft of row up to 1.0 lb/A	1 (Implied)	2.0 lb/A	60 (grain) 30 (forage)	A maximum of 2 lb ai/A may be applied per crop season regardless of the method used. A 30-day PGI has been established.

10)

(continued; footnotes follow)

Table A2 *(continued)*.

Site Application Timing Application Type Application Equipment	Formulation [EPA Reg. No.]	Single Application Rate, ai	Maximum Number of Applications Per Season	Maximum Seasonal Rate, ai	Preharvest Interval, Days	Use Limitations [1]
Barley (continued)						
Foliar application Ground or aerial	8 lb/gal EC [3125-307]	0.5-1.0 lb/A	NS	2.0 lb/A	30 (grain)	A maximum of 2 lb ai/A may be applied per crop season regardless of the method used. Applications may be made in a minimum of 1 gal total volume/acre. The grazing of treated fields is prohibited.
Preplant, preemergence, or postemergence Broadcast application followed by sprinkler irrigation Ground or aerial	15% G [ID850016]	1.0 lb/A	1	NS	60 (grain) 30 (forage)	Use limited to ID, OR, and WA. A 30-day PGI has been established. Straw from harvested fields may be baled and used for feed.
	15% G [OR800034] [WA850036]	1.0 lb/A	1	NS	30	
Beans, Dry						
At-planting Soil injection or Postemergence Sidedress soil Ground	8 lb/gal EC [3125-307]	0.9-1.9 oz/1,000 ft of row [for any row spacing] or 1.0-2.0 lb/A [for a 30-inch row spacing]	1	NS	60	The feeding of treated vines or hay to livestock animals is prohibited.
At-planting Banded soil or Postemergence Sidedress soil Ground	2% G [3125-83]	1.0-1.8 oz/1,000 ft of row [for any row spacing]	1	NS	60 (Post-emergence)	The feeding of treated vines or hay to livestock animals is prohibited.

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(continued, footnotes follow)

Table A2 *(continued)*.

Site Application Timing Application Type Application Equipment	Formulation [EPA Reg. No.]	Single Application Rate, ai	Maximum Number of Applications Per Season	Maximum Seasonal Rate, ai	Preharvest Interval, Days	Use Limitations [1]
Beans, Dry (continued)						
At-planting Banded soil Ground	2% G [3125-126]	1.2 oz/1,000 ft of row	1 (Implied)	NS	NS	The feeding of treated vines or hay to livestock animals is prohibited.
At-planting Banded or sidedress soil Ground	15% G [3125-172]	0.9-1.8 oz/1,000 ft of row [for any row spacing] or 1.0-2.0 lb/A [for a 30-inch row spacing]	1	NS	60	The feeding of treated vines or hay to livestock animals is prohibited.
Beans, Succulent (including snap or green lima)						
At-planting Soil injection Ground	8 lb/gal EC [3125-307]	0.9-1.9 oz/1,000 ft of row [for any row spacing] or 1.0-2.0 lb/A [for a 30-inch row spacing]	1	NS	60	The feeding of treated vines or hay to livestock animals is prohibited.
At-planting Banded soil Ground	2% G [3125-83] [3125-126]	1.0-1.8 oz/1,000 ft of row [for any row spacing]	1	NS	NS	The feeding of treated vines or hay to livestock animals is prohibited.
	2% G [3125-126]	1.2 oz/1,000 ft of row	1 (Implied)	NS	NS	
	15% G [3125-172]	0.9-1.8 oz/1,000 ft of row [for any row spacing] or 1.0-2.0 lb/A [for a 30-inch row spacing]	1	NS	60	

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(continued; footnotes follow)

Table A2 *(continued)*.

Site Application Timing Application Type Application Equipment	Formulation [EPA Reg. No.]	Single Application Rate, ai	Maximum Number of Applications Per Season	Maximum Seasonal Rate, ai	Preharvest Interval, Days	Use Limitations [1]
Bermuda Grass (seed crop)						
Broadcast application Ground or aerial	8 lb/gal EC [CA920025]	1.0 lb/A	NS	NS	7	Use limited to CA. Applications may be made in a minimum of 15 gal/A (ground) or 5 gal/A (aerial). The use as pasture or the use of treated crop for feed, food, forage, or bedding is prohibited.
Broccoli						
Preplant incorporated or postemergence Broadcast soil Ground	15% G [3125-172] 8 lb/gal EC [3125-307]	1.1 oz/1,000 ft of row [for any row spacing] or 1.0 lb/A [for a 36-inch row spacing]	1	NS	NS	Use limited to transplant seed beds.
At-planting Banded soil or soil injection or Postemergence Sidedress soil Ground	2% G [3125-83]	1.0 oz/1,000 ft of row [for any row spacing] or 1 tsp 2% G/plant in the transplant hole	1	NS	14 (Post-emergence)	
	15% G [3125-172] 8 lb/gal EC [3125-307]	1.1 oz/1,000 ft of row [for any row spacing] or 1.0 lb/A [for a 36-inch row spacing]	1	NS	14	

(continued; footnotes follow)

Table A2 *(continued)*.

Site Application Timing Application Type Application Equipment	Formulation [EPA Reg. No.]	Single Application Rate, ai	Maximum Number of Applications Per Season	Maximum Seasonal Rate, ai	Preharvest Interval, Days	Use Limitations [1]
Broccoli (continued)						
At-planting Banded soil	2% G [3125-126]	0.8 oz/1,000 ft of row or 1 tsp 2% G/plant in the transplant hole	1 (Implied)	NS	NS	
Brussels Sprouts						
Preplant incorporated or postemergence Broadcast soil Ground	15% G [3125-172] 8 lb/gal EC [3125-307]	1.1 oz/1,000 ft of row [for any row spacing] or 1.0 lb/A [for a 36-inch row spacing]	1	NS	NS	Use limited to transplant seed beds.
At-planting Banded soil or soil injection or Postemergence Sidedress soil Ground	2% G [3125-83]	1.0 oz/1,000 ft of row [for any row spacing] or 1 tsp 2% G/plant in the transplant hole	2	NS	30 (Post-emergence)	
	15% G [3125-172] 8 lb/gal EC [3125-307]	1.1 oz/1,000 ft of row [for any row spacing] or 1.0 lb/A [for a 36-inch row spacing]	2	NS	30	Applications may be repeated at a 21 day interval.

(continued; footnotes follow)

Table A2 *(continued)*.

Site Application Timing Application Type Application Equipment	Formulation [EPA Reg. No.]	Single Application Rate, ai	Maximum Number of Applications Per Season	Maximum Seasonal Rate, ai	Preharvest Interval, Days	Use Limitations [1]
Brussels Sprouts (continued)						
At-planting Banded soil	2% G [3125-126]	0.8 oz/1,000 ft of row or 1 tsp 2% G/plant in the transplant hole	1 (Implied)	NS	NS	
Cabbage (including tight-heading varieties of Chinese cabbage)						
Preplant incorporated or postemergence Broadcast soil Ground	15% G [3125-172] 8 lb/gal EC [3125-307]	1.1 oz/1,000 ft of row [for any row spacing] or 1.0 lb/A [for a 36-inch row spacing]	1	NS	NS	Use limited to transplant seed beds.
At-planting Banded soil or soil injection or Postemergence Sidedress soil Ground	2% G [3125-83]	1.0 oz/1,000 ft of row [for any row spacing] or 1 tsp 2% G/plant in the transplant hole	1	NS	42 (Post-emergence)	
At-planting Banded soil or soil injection or Postemergence Sidedress soil Ground	15% G [3125-172] 8 lb/gal EC [3125-307]	1.1-1.7 oz/1,000 ft of row [for any row spacing] or 1.0 lb/A [for a 36-inch row spacing]	1	NS	42	

(continued; footnotes follow)

Table A2 *(continued)*.

Site Application Timing Application Type Application Equipment	Formulation [EPA Reg. No.]	Single Application Rate, ai	Maximum Number of Applications Per Season	Maximum Seasonal Rate, ai	Preharvest Interval, Days	Use Limitations [1]
Cabbage (continued)						
At-planting Banded soil	2% G [3125-126]	0.8 oz/1,000 ft of row or 1 tsp 2% G/plant in the transplant hole	1 (Implied)	NS	NS	
Cauliflower						
Preplant incorporated or postemergence Broadcast soil Ground	15% G [3125-172] 8 lb/gal EC [3125-307]	1.1 oz/1,000 ft of row [for any row spacing] or 1.0 lb/A [for a 36-inch row spacing]	1	NS	NS	Use limited to transplant seed beds.
At-planting Banded soil or soil injection or Postemergence Sidedress soil Ground	2% G [3125-83]	1.0 oz/1,000 ft of row [for any row spacing] or 1 tsp 2% G/plant in the transplant hole	2	NS	40 (Post-emergence)	
At-planting Banded soil or soil injection or Postemergence Sidedress soil Ground	15% G [3125-172] 8 lb/gal EC [3125-307]	1.1 oz/1,000 ft of row [for any row spacing] or 1.0 lb/A [for a 36-inch row spacing]	2	NS	40	Applications may be repeated at a 21 day interval.

(continued; footnotes follow)

Table A2 *(continued)*.

Site Application Timing Application Type Application Equipment	Formulation [EPA Reg. No.]	Single Application Rate, ai	Maximum Number of Applications Per Season	Maximum Seasonal Rate, ai	Preharvest Interval, Days	Use Limitations [1]
Cauliflower (continued)						
At-planting Banded soil	2% G [3125-126]	0.8 oz/1,000 ft of row or 1 tsp 2% G/plant in the transplant hole	1 (Implied)	NS	NS	
Coffee Beans						
Preharvest and postharvest Soil (uniformly under the tree canopy) Ground	15% G [3125-172]	0.3-0.6 g/ft of tree height	2	NS	90	Use limited to PR. No more than one preharvest and one postharvest application may be made during the year.
Corn, Field						
At-planting Banded soil or Postemergence Sidedress soil Ground	8 lb/gal EC [3125-307]	1.2 oz/1,000 ft of row [for any row spacing] or 1.0 lb/A [for a 40-inch row spacing]	1 (soil)	NS	28	No more than two applications (one soil and one foliar application) may be made in one season. Foliar applications may be made in a minimum of 1 gal total volume/acre. A 28-day PGI has been established.
Foliar application Ground or aerial	8 lb/gal EC [3125-307]	0.5-1.0 lb/A	1 (foliar)	NS	28	

(continued; footnotes follow)

Table A2 *(continued)*.

Site Application Timing Application Type Application Equipment	Formulation [EPA Reg. No.]	Single Application Rate, ai	Maximum Number of Applications Per Season	Maximum Seasonal Rate, ai	Preharvest Interval, Days	Use Limitations [1]
Corn, Pop						
At-planting Banded soil or Postemergence Sidedress soil Ground	8 lb/gal EC [3125-307]	1.2 oz/1,000 ft of row [for any row spacing] or 1.0 lb/A [for a 40-inch row spacing]	1 (soil)	NS	28	No more than two applications (one soil and one foliar application) may be made in one season. Foliar applications may be made in a minimum of 1 gal total volume/acre. A 28-day PGI has been established.
Foliar application Ground or aerial	8 lb/gal EC [3125-307]	0.5-1.0 lb/A	1 (foliar)	NS	28	
Corn, Sweet						
At-planting Banded soil or Postemergence Sidedress soil Ground	8 lb/gal EC [CA960014]	1.2 oz/1,000 ft of row [for any row spacing] or 1.0 lb/A [for a 40-inch row spacing]	1 (soil)	NS	28	Use limited to CA. A 28-day PGI has been established. Foliar applications may be made in a minimum of 1 gal total volume/acre. No more than two applications (one soil and one foliar application) may be made in one season.
Foliar application Ground or aerial		0.5-1.0 lb/A	1 (foliar)	NS	28	

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(continued; footnotes follow)

Table A2 *(continued)*.

Site Application Timing Application Type Application Equipment	Formulation [EPA Reg. No.]	Single Application Rate, ai	Maximum Number of Applications Per Season	Maximum Seasonal Rate, ai	Preharvest Interval, Days	Use Limitations [1]
Cotton						
Preplant incorporated Banded soil Ground	8 lb/gal EC [3125-307]	0.8-1.2 oz/1,000 ft of row [for any row spacing] or 0.6-1.0 lb/A [for a 40-inch row spacing]	3	NS	NS	A maximum of 3 soil applications of disulfoton may be made per crop season regardless of the method of application or the formulation used. The grazing of treated fields is prohibited.
At-planting/replanting Soil injection or in-furrow soil Ground	8 lb/gal EC [3125-307]	0.8-1.2 oz/1,000 ft of row [for any row spacing] or 0.6-1.0 lb/A [for a 40-inch row spacing]	3	NS	NS	
At-planting/replanting Banded soil Ground	15% G [3125-172]	0.8-1.2 oz/1,000 ft of row [for any row spacing] or 0.6-1.0 lb/A [for a 40-inch row spacing]	1	NS	NS	The feeding of treated forage to livestock is prohibited.
Post-plant (up to first squaring) Soil injection Ground	8 lb/gal EC [3125-307]	2.0 lb/A	1	NS	90	A maximum of 2 postplant applications may be made per crop season with a retreatment interval of 21 days. A maximum of 3 soil applications of disulfoton may be made per crop season regardless of the method of application or the formulation used. The grazing of treated fields is prohibited.
Post-plant Soil injection Ground		1.0 lb/A	1	NS	28	

(continued; footnotes follow)

Table A2 *(continued)*.

Site Application Timing Application Type Application Equipment	Formulation [EPA Reg. No.]	Single Application Rate, ai	Maximum Number of Applications Per Season	Maximum Seasonal Rate, ai	Preharvest Interval, Days	Use Limitations [1]
Cotton (continued)						
Post-plant Sidedress soil incorporated Ground	15% G [3125-172]	0.8-1.2 oz/1,000 ft of row [for any row spacing] or 0.6-1.0 lb/A [for a 40-inch row spacing]	1	NS	28	Use limited to irrigated cotton only. A post-plant application may be made 21 days following an at-planting application. The feeding of treated forage is prohibited.
Foliar (prior to bloom) Ground or aerial	8 lb/gal EC [3125-307]	0.19-0.56 lb/A	3	NS	NS	Applications may be made in a minimum of 1 gal total volume/acre. If foliar applications are made, then soil applications may not be made during the same crop year.
Foliar (before bolls open) Ground or aerial	8 lb/gal EC [TX860007]	0.1-0.2 lb/A	2	NS	30	Use limited to TX. Applications may be made in a minimum of 1 gal total volume/acre. The grazing or feeding of treated forage to livestock is prohibited.
Seed treatment	95% RTU [3125-173]	3.33-6.65 oz/100 lb of seed	1	NS	Not applicable (NA)	Use of treated seeds for food or animal feed, processing of treated seeds for oil, or mixing of treated seeds with food or animal feed is prohibited.
Lentils						
At-planting Drill/broadcast soil or soil injection or Postemergence Sidedress soil Ground	15% G [3125-172] 8 lb/gal EC [3125-307]	1.0-2.5 lb/A	1	NS	50	The feeding of treated vines or hay to livestock animals is prohibited.

(continued; footnotes follow)

Table A2 *(continued)*.

Site Application Timing Application Type Application Equipment	Formulation [EPA Reg. No.]	Single Application Rate, ai	Maximum Number of Applications Per Season	Maximum Seasonal Rate, ai	Preharvest Interval, Days	Use Limitations [1]
Lettuce						
At-planting or post-plant Banded soil or soil injection Ground	8 lb/gal EC [3125-307]	0.6-1.2 oz/1,000 ft of row [for any row spacing] or 1.0-2.0 lb/A [for a 20-inch row spacing]	1	NS	60	Application to transplanted lettuce is prohibited.
At-planting Banded soil or soil injection Ground	8 lb/gal EC [CA810044]	1.2 oz/1,000 ft of row [for any row spacing] or 2.0 lb/A [for a 20-inch row spacing]	1 (Implied)	NS	60	Use limited to CA. Application may be made in a minimum of 20 gal/A.
	2% G [3125-83]	0.8-1.2 oz/1,000 ft of row [for any row spacing]	1 (Implied)	NS	NS	
	2% G [3125-126]	1.2 oz/1,000 ft of row	1 (Implied)	NS	NS	
	15% G [3125-172]	0.6-1.2 oz/1,000 ft of row or 1.0-2.0 lb/A [for a 20-inch row spacing]	1 (Implied)	NS	NS	Application to transplanted lettuce is prohibited.

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(continued; footnotes follow)

Table A2 *(continued)*.

Site Application Timing Application Type Application Equipment	Formulation [EPA Reg. No.]	Single Application Rate, ai	Maximum Number of Applications Per Season	Maximum Seasonal Rate, ai	Preharvest Interval, Days	Use Limitations [1]
Oats						
Broadcast application Ground or aerial	8 lb/gal EC [ME880001]	0.5 lb/A	1	NS	60 (grain)	Use limited to ME. Application may be made in a minimum of 20 gal/A (ground) or 1 gal/A (aerial). The grazing of treated fields or cutting for forage is prohibited prior to the grain harvest stage (normal maturity).
Peanuts						
At-planting Banded soil or Postemergence Sidedress soil Ground	15% G [3125-172]	1.1-2.2 oz/1,000 ft of row [for any row spacing] or 1.0-2.0 lb/A [for a 36-inch row spacing]	1 (Implied)	NS	NS	
At-planting In-furrow or At-pegging Banded or sidedress soil Ground	15% G [NC920011] [VA920006]	1.1-2.2 oz/1,000 ft of row [for any row spacing] or 1.0-2.0 lb/A [for a 36-inch row spacing]	2	NS	72	Use limited to NC and VA. A 72 day PGI has been established.
Peas						
At-planting Banded soil Ground	2% G [3125-83]	1.0 oz/1,000 ft of row [for any row spacing]	1 (Implied)	NS	NS	The feeding of treated vines or hay to livestock animals is prohibited.
	2% G [3125-126]	0.8 oz/1,000 ft of row	1 (Implied)	NS	NS	

(continued; footnotes follow)

Table A2 *(continued)*.

Site Application Timing Application Type Application Equipment	Formulation [EPA Reg. No.]	Single Application Rate, ai	Maximum Number of Applications Per Season	Maximum Seasonal Rate, ai	Preharvest Interval, Days	Use Limitations [1]
Peas (continued)						
At-planting Drill/broadcast soil or soil injection or Postemergence Sidedress soil Ground	15% G [3125-172] 8 lb/gal EC [3125-307]	1.0-2.5 lb/A	1	NS	50	The feeding of treated vines or hay to livestock animals is prohibited.
Pecan						
Preharvest Banded soil (incorporated) Ground	15% G [3125-172] 8 lb/gal EC [3125-307]	1.5-3.0 lb/A	1	NS	80	Use limited to South Central and Southwestern States. The grazing of grass underneath trees is prohibited. The tank mixing of the formulated product with phosalone is not recommended.
Foliar application Ground	8 lb/gal EC [3125-307]	0.75-1.5 lb/A	3	NS	30	The grazing of grass underneath trees is prohibited. The tank mixing of the formulated product with phosalone is not recommended.
Foliar application Aerial		0.75-1.0 lb/A	3	NS	30	Applications may be made in a minimum of 5 gallons total volume per acre. The grazing of grass underneath trees is prohibited. The tank mixing of the formulated product with phosalone is not recommended.

(continued; footnotes follow)

Table A2 *(continued)*.

Site Application Timing Application Type Application Equipment	Formulation [EPA Reg. No.]	Single Application Rate, ai	Maximum Number of Applications Per Season	Maximum Seasonal Rate, ai	Preharvest Interval, Days	Use Limitations [1]
Pepper						
At-planting/transplanting Banded soil Ground	15% G [3125-172]	1.0-2.0 oz/1,000 ft of row [for any row spacing] or 1.0-2.0 lb/A [for a 32-inch row spacing]	1	NS	90	
Postemergence Sidedress soil Ground	8 lb/gal EC [CA770036]	2.0 lb/A	1	NS	60	Use limited to CA.
Potato						
Preplant incorporated or postemergence Broadcast soil incorporated Ground	15% G [3125-172] 8 lb/gal EC [3125-307]	3.0-4.0 lb/A	2	NS	75	No more than two soil applications of the 8 lb/gal EC formulation may be made per crop season regardless of the method used. The tank mixing of the formulated product with phosalone is not recommended.
At-planting Banded/sidedress soil Ground	2% G [3125-83]	2.4-3.6 oz/1,000 ft of row [for any row spacing]	1 (Implied)	NS	75	The tank mixing of the formulated product with phosalone is not recommended.
At-planting Banded Ground	2% G [3125-126]	2.4 oz/1,000 ft of row	1 (Implied)	NS	NS	
At-planting Banded soil or soil injection or Postemergence Sidedress soil Ground	15% G [3125-172] 8 lb/gal EC [3125-307]	2.3-3.5 oz/1,000 ft of row [for any row spacing] or 2.0-3.1 lb/A [for a 38-inch row spacing]	2	NS	75	No more than two soil applications of the 8 lb/gal EC formulation may be made per crop season regardless of the method used. The tank mixing of the formulated product with phosalone is not recommended.

(continued; footnotes follow)

Table A2 *(continued)*.

Site Application Timing Application Type Application Equipment	Formulation [EPA Reg. No.]	Single Application Rate, ai	Maximum Number of Applications Per Season	Maximum Seasonal Rate, ai	Preharvest Interval, Days	Use Limitations [1]
Potato (continued)						
Foliar application Ground or aerial	8 lb/gal EC [3125-307]	0.375-1.0 lb/A	3	NS	30	Applications may be made in a minimum of 1 gallon total volume per acre. The tank mixing of the formulated product with phosalone is not recommended.
Foliar application Ground (sprinkler irrigation)	8 lb/gal EC [3125-307]	3.0 lb/A	1	NS	60	Use limited to ID, OR, UT, and WA. Application may be made following an at-planting application.
Soil and/or foliar application Ground (sprinkler irrigation)	15% G [ID830035] [OR830057]	3.0 lb/A	2 (Implied)	NS	110 (soil) 75 (foliar)	Use limited to ID and OR. Applications may be repeated at a 28-day interval. If two applications are made, a 110-day PHI has been established for soil treatments and a 75-day PHI has been established for foliar treatments.
Sorghum						
At-planting Banded/in-furrow soil Ground	15% G [3125-172]	0.9-1.2 oz/1,000 ft of row [for any row spacing] or 0.8-1.0 lb/A [for a 40-inch row spacing]	1 (Implied)	NS	NS	
Foliar broadcast Ground or aerial	15% G [3125-172]	1.2 oz/1,000 ft of row [for any row spacing] or 1.0 lb/A [for a 40-inch row spacing]	1 (Implied)	NS	30 (grain) 45 (forage and fodder)	Foliar broadcast application may be made directly into the whorl following at-planting application.

(continued; footnotes follow)

Table A2 *(continued)*.

Site Application Timing Application Type Application Equipment	Formulation [EPA Reg. No.]	Single Application Rate, ai	Maximum Number of Applications Per Season	Maximum Seasonal Rate, ai	Preharvest Interval, Days	Use Limitations [1]
Sorghum (continued)						
At-planting Banded/in-furrow soil Ground	8 lb/gal EC [3125-307]	0.9-1.2 oz/1,000 ft of row [for any row spacing] or 0.8-1.0 lb/A [for a 40-inch row spacing]	1 (Implied)	3.5 lb/A (2 soil plus 3 foliar applications)	NS	A maximum of 5 applications (2 soil applications plus 3 foliar applications) may be made to a single sorghum crop.
Post-plant (up to boot stage) Sidedress soil Ground	8 lb/gal EC [3125-307]	1.2 oz/1,000 ft of row [for any row spacing] or 1.0 lb/A [for a 40-inch row spacing]	NS	3.5 lb/A (2 soil plus 3 foliar applications)	45 (forage and fodder)	
Foliar broadcast Ground or aerial	8 lb/gal EC [3125-307]	0.25-0.5 lb/A	3	3.5 lb/A (2 soil plus 3 foliar applications)	See "use limitations"	Applications may be made in a minimum of 5 gal/A (ground) or 1 gal/A (aerial). A 34-day PHI (grain) and a 45 day PGI (forage and fodder) have been established for any soil plus any foliar application. A 7-day PHI (grain) and a 45 day PGI (forage and fodder) have been established for one or two foliar applications not preceded by soil applications. A 34 day PHI (grain) and a 60-day PGI (forage and fodder) have been established after three foliar applications not preceded by soil applications.

(continued; footnotes follow)

Table A2 *(continued)*.

Site Application Timing Application Type Application Equipment	Formulation [EPA Reg. No.]	Single Application Rate, ai	Maximum Number of Applications Per Season	Maximum Seasonal Rate, ai	Preharvest Interval, Days	Use Limitations [1]
Soybeans						
At-planting Banded soil Ground	15% G [3125-172]	1.2 oz/1,000 ft of row [for any row spacing] or 1.0 lb/A [for a 36-inch row spacing]	1 (Implied)	NS	75 (forage and hay)	
Postemergence Sidedress soil Ground	15% G [3125-172]	1.2 oz/1,000 ft of row [for any row spacing] or 1.0 lb/A [for a 36-inch row spacing]	1 (Implied)	NS	NS	Use limited to soybeans grown for seed. A label restriction prohibits the use of soybeans grown for seed for feed, food, or forage.
Tobacco						
Preplant incorporated Broadcast or banded soil Ground	15% G [3125-172]	3.0-6.0 oz/1,000 ft of row [for any row spacing] or 2.0-4.0 lb/A [for a 48-inch row spacing]	1	NS	NS	
Preplant/postemergence (incorporated) Broadcast soil Ground	15% G [3125-172]	0.15 oz/100 sq. ft of transplant bed	1	NS	NS	Use limited to tobacco transplant seed beds.
Tomato						
Preplant incorporated Broadcast soil Ground	8 lb/gal EC [3125-307]	3.0 lb/A	1	NS	NS	Use limited to transplant seed beds.

(continued; footnotes follow)

Table A2 *(continued)*.

Site Application Timing Application Type Application Equipment	Formulation [EPA Reg. No.]	Single Application Rate, ai	Maximum Number of Applications Per Season	Maximum Seasonal Rate, ai	Preharvest Interval, Days	Use Limitations [1]
Tomato (continued)						
At-planting Soil injection or Postemergence Sidedress soil Ground	8 lb/gal EC [3125-307]	1.2-3.5 oz/1,000 ft of row [for any row spacing] or 1.0-3.0 lb/A [for a 38-inch row spacing]	2 (Implied)	NS	30	When two applications are made, applications should be made at 2.0 lb/A (2.4 oz/1,000 ft of row) at a 21 day interval.
Triticale						
Foliar application (spring or fall) Ground or aerial	8 lb/gal EC [WY870004]	0.25-0.75 lb/A	4 (Implied)	NS	30 (grain)	Use limited to WY. Two applications may be made in the fall with a 30 day retreatment interval followed by two applications in the spring at green-up with a retreatment interval of 30 days. Applications may be made in a minimum of 1 gal total volume/acre. The grazing of treated fields or cutting for forage after application is prohibited.
Wheat						
At-planting (fall) Drill or broadcast soil Ground	15% G [3125-172]	0.25 oz/1,000 ft of row or 1.0 lb/A	1	NS	75 (forage)	A 75-day PGI has been established.
At-planting Drill or broadcast soil Ground	15% G [ID850016] [OR800034] [WA850036]	1.0 lb/A	1	NS	75 (forage)	Use limited to ID, OR, and WA. A 75 day PGI has been established. Straw from harvested fields may be baled and used for feed.
	15% G [MT800004]	1.0 lb/A	1	NS	60	Use limited to MT. A 60 day PGI has been established. Straw from harvested fields may be baled and used for feed

(continued; footnotes follow)

Table A2 *(continued)*.

Site Application Timing Application Type Application Equipment	Formulation [EPA Reg. No.]	Single Application Rate, ai	Maximum Number of Applications Per Season	Maximum Seasonal Rate, ai	Preharvest Interval, Days	Use Limitations [1]
Wheat (continued)						
At-planting (fall) Soil injection Ground	8 lb/gal EC [3125-307]	0.25 oz/1,000 ft of row or 1.0 lb/A	NS	NS	NS	The grazing of treated fields or cutting for forage after application is prohibited.
Foliar application (spring or fall) Ground or aerial	8 lb/gal EC [3125-307]	0.25-0.75 lb/A	3 (Implied)	NS	30 (grain)	An application may be made in the fall followed by applications in the spring at green-up with a retreatment interval of 30 days. Applications may be made in a minimum of 1 gal total volume/acre. The grazing of treated fields or cutting for forage after application is prohibited.
	8 lb/gal EC [NM880001] [OK880002] [TX900004]	0.25-0.75 lb/A	2	NS	30 (grain)	Use limited to NM, OK, and TX. Application may only be made if no at-planting application was made. Two applications may be made with a retreatment interval of 14 days. Applications may be made in a minimum of 1 gal total volume/acre. The grazing of treated fields or cutting for forage after application is prohibited.
Postemergence Broadcast application Ground or aerial	15% G [CA760019]	1.0 lb/A	1	NS	30	Use limited to CA. The grazing of treated fields or cutting greenchop for forage is prohibited. Straw from harvested fields may be baled and used for feed.

(continued; footnotes follow)

Table A2 *(continued)*.

Site Application Timing Application Type Application Equipment	Formulation [EPA Reg. No.]	Single Application Rate, ai	Maximum Number of Applications Per Season	Maximum Seasonal Rate, ai	Preharvest Interval, Days	Use Limitations [1]
Wheat (continued)						
Preplant, preemergence, or postemergence Broadcast application followed by sprinkler irrigation Ground or aerial	15% G [ID850016] [OR800034] [WA850036]	1.0 lb/A	1	NS	30	Use limited to ID, OR, and WA. A 30 day PGI has been established. Straw from harvested fields may be baled and used for feed.

[1] The restricted entry interval (REI) for the 15% G (EPA Reg. No. 3125-172) and the 8 lb/gal EC (EPA Reg. No. 3125-307) formulations is 48 hours; except in outdoor areas where rainfall is less than 25 inches per year when each 48 hour REI is increased to 72 hours.

[2] When disulfoton is used at-planting, the registered formulation should not be applied directly onto the seed.

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Table B. Residue Chemistry Science Assessments for Reregistration of Disulfoton.

GLN: Data Requirements	Current Tolerances, ppm [40 CFR]	Must Additional Data Be Submitted?	References
860.1200: Directions for Use	N/A = Not Applicable	Yes [2]	See Tables A1 and A2.
860.1300: Plant Metabolism	N/A	Yes	00032409, 00034557, 00071767, 00089402, 00089403, 00090339, 00095498, 00095555, 43222401-43222404 [3], 44146501-44146502 [3]
860.1300: Livestock Metabolism	N/A	No	40939001-40939002 [4]
860.1340: Residue Analytical Methods			
- Plant commodities	N/A	Reserved [5]	00032409, 00041055, 00071233, 00071235, 00071237, 00071243, 00071245, 00089401, 00094212, 00095542, 00095618
- Livestock commodities	N/A	No [6]	
860.1360: Multiresidue Methods	N/A	No	
860.1380: Storage Stability Data	N/A	Yes [7]	00089899, 00090164, 00095579, 43447705 [8], 43957301 [8], 44248001 [9], 44248004 [10]
860.1500: Crop Field Trials			
Root and Tuber Vegetables Group			
- Beets, sugar	0.5 [180.183(a)]	No [11]	00095570, 00095611
- Potatoes	0.75 [180.183(a)]	No	00071238, 00095501, 40156610

(continued; footnotes follow)

Table B (continued).

GLN: Data Requirements	Current Tolerances, ppm [40 CFR]	Must Additional Data Be Submitted?	References
Leaves of Root and Tuber Vegetables Group			
- Beets, sugar, tops	2.0 [180.183(a)]	No [11]	00095570, 00095611
Leafy Vegetables (except *Brassica* Vegetables) Group			
- Lettuce	0.75 [180.183(a)]	Yes [12]	00071234, 00089894, **40156601**, 44248003 [13]
- Spinach	0.75 [180.183(a)]	No [11]	00090337
Brassica (Cole) Leafy Vegetables Group			
- Broccoli	0.75 [180.183(a)]	No	00089855, 00090165, **40156605**
- Brussels sprouts	0.75 [180.183(a)]	No	00071234, 00095543, **40156604**
- Cabbage	0.75 [180.183(a)]	No	00090165, **40156602**
- Cauliflower	0.75 [180.183(a)]	No	00071234, 00095543, **40156603**
Legume Vegetables (Succulent or Dried) Group			
- Beans, succulent and dry	0.75 (dry, lima, and snap) [180.183(a)]	No	00071234, 00089893, 00089896, 00095585
- Peas, succulent and dry	0.75 [180.183(a)]	No	00071234, 00095543
- Soybeans, seed and aspirated grain fractions	0.1 (seed) [180.183(a)]	Yes [14]	00095549, **40156607**

(continued; footnotes follow)

Table B (*continued*).

GLN: Data Requirements	Current Tolerances, ppm [40 CFR]	Must Additional Data Be Submitted?	References
Foliage of Legume Vegetables Group			
- Beans, forage and hay	5.0 (vines) [180.183(a)]	Yes [15]	00071234, 00089893, 00089896, 00095585
- Peas, vines and hay	5.0 (vines) [180.183(a)]	Yes [16]	00071234, 00095543
- Soybeans, forage and hay	0.25 [180.183(a)]	No	00095549, **40156607**
Fruiting Vegetables (except Cucurbits) Group			
- Peppers	0.1 [180.183(a)]	No	00036249
- Tomatoes	0.75 [180.183(a)]	No [17]	00071234, 00089895, **40204309**
Tree Nuts Group			
- Pecans	0.75 [180.183(a)]	No	00057270
Cereal Grains Group			
- Barley, grain	0.75 [180.183(a)]	No [18]	00089892
- Corn, field, grain and aspirated grain fractions	0.3 (grain) [180.183(a)]	No	00091556, 00095554, 44248009 [19]
- Corn, pop	0.3 [180.183(a)]	No	
- Corn, sweet (K+CWHR)	0.3 [180.183(a)]	No	00041047, 00091556

(continued; footnotes follow)

Table B (continued)

GLN: Data Requirements	Current Tolerances, ppm [40 CFR]	Must Additional Data Be Submitted?	References [1]
- Oats, grain	0.75 [180.183(a)]	No	00089892
- Rice, grain	0.75 [180.183(a)]	No [11]	00090333, 00095590
- Sorghum, grain and aspirated grain fractions	0.75 (grain) [180.183(a)]	No	00095502, 00095554, 00095556, 00095615, **40306401**, 44248007 [19]
- Wheat, grain and aspirated grain fractions	0.3 (grain) [180.183(a)]	No [20]	00090165, 00095551, **40156608**, **40156609**, 44248010 [19]
Forage, Fodder, and Straw of Cereal Grains Group			
- Barley, hay and straw	5.0 (green fodder and straw) [180.183(a)]	No [18,21]	00089892, 40204301
- Corn, field, forage and stover	5.0 [180.183(a)]	No	00091556, 00095554
- Corn, pop, stover	5.0 (forage and fodder) [180.183(a)]	No	
- Corn, sweet, forage and stover	5.0 [180.183(a)]	No	00041047, 00091556
- Oats, forage, hay, and straw	5.0 (green fodder and straw) [180.183(a)]	No [22]	00089892
- Rice, straw	5.0 [180.183(a)]	No [11]	00090333, 00095590

(continued; footnotes follow)

Table B *(continued)*

GLN: Data Requirements	Current Tolerances, ppm [40 CFR]	Must Additional Data Be Submitted?	References
- Sorghum, forage and stover	5.0 [180.183(a)]	No [23]	00095502, 00095554, 00095556, 00095615
- Wheat, forage, hay, and straw	5.0 (green fodder and straw) [180.183(a)]	Yes [20,24]	00090165, 00095551, **40156608**
Nongrass Animal Feeds (Forage, Fodder, Straw, and Hay) Group			
- Alfalfa, forage and hay	5.0 (fresh); 12.0 (hay) [180.183(a)]	No [11]	00090165, 00095502, **40204305**
- Clover, forage and hay	5.0 (fresh); 12.0 (hay) [180.183(a)]	No [11]	00091497
Miscellaneous Commodities			
- Asparagus	0.1 [180.183(b)]	No [25]	00109459, 40005301 [26], **40056701**
- Coffee, beans	0.3 [180.183(a)]	No	00090133, 00095617, **40204302**
- Cotton, seed and gin byproducts	0.75 (seed) [180.183(a)]	Yes [27]	00090234, 00095622, **00162859** [28], **40204304**
- Hops	0.5 [180.183(a)]	No [11]	00032409
- Peanuts, nutmeat and hay	0.75 (nutmeat); 5.0 (hay); 0.3 (hulls) [180.183(a)]	No [29]	00090337, **40204311**
- Pineapple	0.75 (pineapple); 5.0 (foliage) [180.183(a)]	No [11]	00090335

(continued; footnotes follow)

Table B (continued).

GLN: Data Requirements	Current Tolerances, ppm [40 CFR]	Must Additional Data Be Submitted?	References
- Sugarcane	0.3 [180.183(a)]	No [11]	00095548
- Tobacco	N/A	No [30]	00002477, 00095498, **40204303**, 42850201 [31], 44146503 [32], 44301901 [33]
- Crops grown solely for seed	N/A	No [34]	
860.1520: Processed Food/Feed			
- Barley	None established	No [35]	
- Beet, sugar	5.0 (dried pulp) [186.1950]	No [11]	
- Coffee	None established	No	44248008 [13]
- Corn, field	None established	No	**40204307**, 44248009 [19]
- Cottonseed	None established	No	44248006 [13]
- Oats	None established	No [36]	
- Peanuts	None established	No	**40768901**
- Pineapples	5.0 (bran) [186.1950]	No [11]	
- Potatoes	None established	No	44248005 [10]
- Rice	None established	No [11]	
- Sorghum	None established	Yes [37]	
- Soybean	None established	No	00095549, **40306402**
- Sugarcane	None established	No [11]	00095548

(continued; footnotes follow)

Table B (continued)

GLN: Data Requirements	Current Tolerances, ppm [40 CFR]	Must Additional Data Be Submitted?	References
- Tomatoes	None established	No	**40204310**
- Wheat	None established	No	**40561201**, 44248010 [9]
860.1480: Meat, Milk, Poultry, Eggs			
- Milk and the Fat, Meat, and Meat Byproducts of Cattle, Goats, Hogs, Horses, and Sheep	None established	Reserved [38]	PP 7F1895
- Eggs and the Fat, Meat, and Meat Byproducts of Poultry	None established	Reserved [38]	PP 7F1895
860.1400: Water, Fish, and Irrigated Crops	None established	N/A	
860.1460: Food Handling	None established	N/A	
860.1850: Confined Rotational Crops	N/A	No	40120601 [39], 43447701-43447702 [8]
860.1900: Field Rotational Crops	None	Yes [40]	40120602 [39], 43447703-43447704 [8]

[1] **Bolded** references were reviewed in the Residue Chemistry Chapter of the Disulfoton Reregistration Standard Update dated 1/25/91. Unbolded references, unless otherwise indicated, were reviewed in the Residue Chemistry Chapter of the Disulfoton Reregistration Standard dated 4/6/84. All other references were reviewed as indicated in these endnotes.

[2] Label amendments are required for all disulfoton end-use products to specify that application using aerial equipment, when allowed, should be made in a minimum of 2 gal/A, or 10 gal/A for orchard crops.

Additional label amendments are required for specific crops; required amendments are detailed in the endnotes for the crops under 860.1500. The status of data requirements in this Table depends on incorporation of all required amendments. Amendments are also required for certain uses to qualify as nonfood, as discussed in the text section 860.1200.

[3] CBRS Nos. 13715, 17656, and 17657; DP Barcodes D203210, D231362, and D231369, 3/18/97, J. Abbotts.

[4] CB No. 4818, 3/30/89, H. Fonouni.

(continued; footnotes follow)

Table B *(continued)*.

[5] Plant metabolism data remain outstanding. If the required plant metabolism data indicate additional disulfoton residues of concern, then additional analytical methodology will be required.

[6] Currently, there are no tolerances for livestock commodities.
D241353, 12/15/97, J. Abbotts: The Update to the Residue Chemistry Chapter (1/25/91) concluded that Method II in PAM, Vol. II was acceptable for data collection and enforcement purposes for livestock commodities, for identified tolerance residues (see Figure 1). Based on Agency laboratory validation, LOQ was 0.05 ppm for meat and 0.01 ppm for milk.

[7] Storage stability data for livestock commodities will be required to support the outstanding livestock feeding studies unless samples are stored less than one month prior to analysis.

[8] CBRS Nos. 14708 and 17253, DP Barcodes D209425 and D226575, 4/16/97, J. Abbotts.

[9] CBRS No. 17896, DP Barcode D235166, 6/18/97, J. Abbotts.

[10] CBRS No. 17898, DP Barcode D235170, 5/14/97, J. Abbotts.

[11] The basic registrant is not supporting use of disulfoton on the following crops: alfalfa, clover, hops, pineapple, rice, spinach, sugar beets, and sugarcane. All Bayer-registered uses on these crops have been canceled. Provided corresponding tolerances are revoked, no additional residue data will be required.

[12] The available field trial data support reregistration of the 8 lb/gal EC formulation for one soil application not to exceed 2 lb ai/A with a 60-day PHI. Field trial data to support the G formulation remain outstanding.

[13] CBRS No. 17899, DP Barcode D235171, 7/8/97, J. Abbotts.

[14] Data for soybean aspirated grain fractions are not required as disulfoton use on soybeans is early season, and processing data indicated that surface residues are not expected to be greater than residues in or on whole seed. For use on crops grown for seed, see discussion in this document under 860.1500; label amendments or additional field trial data are required.

[15] Field trial data for cowpea forage and hay must be submitted. If product labels are modified to exclude use on cowpeas, then field trial data are not required.

[16] Field trial data for field pea vines and hay must be submitted. If product labels are modified to exclude use on field peas, then field trial data are not required.

[17] Field residue data to support use in transplant seed beds are not available. Unless the registrant submits field residue data for tomatoes grown in treated transplant beds, this use must be removed from product labels.

[18] Product labels must be amended to reflect the use pattern for which adequate field trial data have been submitted: one soil application followed by one foliar application at 1 lb ai/A/application with a 30-day PHI. All restrictions against the grazing of treated fields must be removed from product labels and replaced with at least a 30-day PGI/PHI.

[19] CBRS No. 17897, DP Barcode D235168, 5/22/97, J. Abbotts.

Table B (continued).

[20] Product labels must be amended to reflect the use pattern for which adequate field trial data have been submitted: one soil application at 1 lb ai/A followed by two foliar applications at 0.75 lb ai/A/application with a 30-day PHI for foliar applications and a 75-day PHI for soil applications. All restrictions against the grazing of treated fields or cutting of treated fields for forage must be removed from product labels and replaced with at least a 30-day PGI/PHI for foliar applications and a 75-day PGI/PHI for soil applications.

An SLN exists for foliar use of disulfoton on triticale (WY870004). Unless field trial data to support this use have been submitted since the Update, SLN No. WY870004 must be canceled.

[21] [Deleted in editing]

[22] The Agency currently recognizes oat hay as a RAC (Table 1, OPPTS 860.1000). The required data for wheat hay can be translated to oat hay.

[23] Product labels must be amended to reflect the use pattern for which adequate field trial data have been submitted: one at-plant application and one sidedress application at 1 lb ai/A/application, followed by three foliar applications at 0.5 lb ai/A/application, with a 45-day PHI for forage and fodder.

[24] The Agency currently recognizes wheat hay as a RAC (Table 1, OPPTS 860.1000). Once label conditions are consistent with field trial data submitted (see note 20), a tolerance for wheat hay will be established.

[25] EPA SLN No. CA840192 must be modified to reflect a 45-day PHI; alternatively, field trial data reflecting a 30-day PHI may be submitted.

[26] CB No. 1688, 12/10/86, M. Metzger.

[27] No field trial data are available to support the maximum use rate for foliar application of disulfoton to cotton. Therefore, labels must be amended such that foliar use rates are consistent with available data.

The Agency currently recognizes cotton gin byproducts (commonly called gin trash, which include the plant residues from ginning cotton consisting of burrs, leaves, stems, lint, immature seeds, and sand and/or dirt) as a RAC (Table 1, OPPTS 860.1000). Data depicting the magnitude of disulfoton residues of concern in/on cotton gin byproducts following application(s) of a representative formulation according to the maximum registered use patterns are required. Cotton must be harvested by commercial equipment (stripper and mechanical picker) to provide an adequate representation of plant residue for the ginning process. A minimum of three field trials for each type of harvesting (stripper and mechanical picker) are required, for a total of six field trials. An appropriate tolerance for this RAC should be proposed once acceptable data have been submitted and evaluated.

[28] Also reviewed in CB No. 1394, 9/24/86, F. Suhre.

[29] Two 24(c) registrations exist for use of disulfoton on peanuts in-furrow at-planting (SLN Nos. NC920011 and VA920006). CBRS 10141, 7/23/92, S.A. Knizner, concluded that available field trial data indicate that residues may exceed the tolerance for peanut hay when peanuts are treated according to that use. Either SLN Nos. NC920011 and VA920006 should be canceled, or the registrant may modify the labels for these SLNs to establish feeding restrictions for peanut hay.

[30] DP Barcode D238139, 9/23/97, J. Abbotts.

Table B (*continued*).

[31] CBRS No. 12817, DP Barcode D196216, 11/24/93, D. Miller.

[32] CBRS No. 17659, DP Barcode D231360, 3/7/97, J. Abbotts.

[33] DP Barcode D238139, 9/23/97, J. Abbotts.

[34] The registrant has stated that uses on Bermuda grass, carrots, garlic, onions, radishes, and turnips grown for seed are not being supported for reregistration. Currently, uses on Bermuda grass and radish grown for seed exist. Use on Bermuda grass, under SLN No. CA920025, must be canceled (CBTS No. 10947, DP Barcode D185316, 12/18/92, W. Wassell) as there are no supporting residue data available. However, use on radish grown for seed, under SLN Nos. WA920026 and WA920027, can be considered a nonfood use (CBTS No. 15111, DP Barcode D212168, 2/14/95, B. Schneider). Therefore, no field residue data are required to support use on radish grown for seed and the registrant may retain this use.

[35] Data for wheat processed commodities were translated to barley.

[36] Data for wheat processed commodities were translated to oats.

[37] Residue data for sorghum syrup must be submitted. If product labels are modified to exclude use on sweet sorghum, then residue data are not required.

[38] D241353, 12/15/97, J. Abbotts: Available livestock feeding data are acceptable, up to feeding levels of 7 ppm for ruminants and 36 ppm for poultry. Tolerances were recommended for milk and ruminant meat; tolerances for poultry commodities are not required. Once the nature of the residue in plants is adequately understood and magnitude of the residue data are available on all major feed items, the need for this requirement will be reevaluated.

[39] EFGWB Review, DP Barcode D157584, 2/12/92, A. Abramovitch.

[40] Rotational tolerances requirements can be waived for cereal grains at any plantback interval and for leafy vegetables provided the plantback interval is at least 240 days. Extensive field rotational crop trials must be conducted for all other crops for which rotation is desired. The Agency would not object if the registrant delayed initiation of rotational trials until determination of the residues to be regulated in plant commodities, provided additional plant metabolism data were submitted in a timely manner.

TOLERANCE REASSESSMENT SUMMARY

Tolerances for residues of disulfoton in/on plant commodities [40 CFR §180.183(a) and (b)] are currently expressed in terms of the combined residues of disulfoton and its cholinesterase-inhibiting metabolites, calculated as demeton. Tolerances for residues of disulfoton in processed feed commodities [40 CFR §186.1950] are presently expressed in terms of the residues of disulfoton *per se*, calculated as demeton. Plant metabolism data remain outstanding. Therefore, all tolerance reassessment presented here is tentative. Until outstanding plant metabolism data are submitted, the Agency has determined that residues to be regulated in plant commodities are disulfoton, disulfoton oxygen analog, and their sulfoxides and sulfones. In addition, the preferred enforcement method (GC method) calculates residues in terms of disulfoton. Therefore, the tolerance expression should be revised to state that tolerances are for the combined residues of disulfoton, disulfoton oxygen analog, and their sulfoxides and sulfones, each designated by full chemical name (Table A), calculated as disulfoton.

The tolerances listed in 40 CFR need to be reorganized in order to conform with the requirements of the Food Quality Protection Act (FQPA). The FQPA amends the FFDCA to bring all EPA pesticide tolerance-setting activities under a single section of the statute, Section 408. The FQPA authorizes the conversion of all existing Section 409 tolerances for pesticide residues in processed food/feed into Section 408 tolerances.

The Agency has recently updated the list of raw agricultural and processed commodities and feedstuffs derived from crops (Table 1, OPPTS GLN 860.1000). As a result of changes to Table 1, disulfoton tolerances for certain commodities which have been removed from Table 1 need to be revoked, and some commodity definitions must be corrected. In addition, tolerances for commodities for which there are currently no registered uses of disulfoton need to be revoked. A summary of disulfoton tolerance reassessments is presented in Table C.

Tolerances Listed Under 40 CFR §180.183(a):

Pending label amendments for some crops, adequate data are available to reassess the established tolerances for the following commodities, as defined: barley, grain; barley, straw; beans, dry; beans, lima; beans, snap; broccoli; Brussels sprouts; cabbage; cauliflower; coffee beans; corn, field, fodder; corn, field, forage; corn, grain; corn, pop, grain; corn, pop, fodder; corn, sweet, fodder; corn, sweet, forage; corn, sweet, grain (K+CWHR); cottonseed; oats, fodder, green; oats, grain; oats, straw; peanuts; peanuts, hay; peas; pecans; peppers; potatoes; grain sorghum, fodder; grain sorghum, forage; grain sorghum, grain; soybeans; soybeans, forage; soybeans, hay; tomatoes; wheat, fodder, green; wheat, grain; and wheat, straw.

Insufficient field trial data are available to reassess the tolerances for the following commodities, as defined: beans, vines; lettuce; peas, vines. The available field trial data for lettuce indicate that an increased tolerance for leaf lettuce is required.

The available residue data indicate that the established tolerance levels for the following commodities can be decreased: barley, grain; coffee beans; corn, field, fodder; corn, pop, fodder; corn, sweet, fodder; peanuts; pecans; potatoes; and wheat, grain.

The established tolerances for the following commodities should be revoked as there are currently no Bayer-registered uses of disulfoton on these commodities: alfalfa, fresh; alfalfa, hay; beets, sugar, roots; beets, sugar, tops; clover, fresh; clover, hay; hops; pineapples; pineapples, foliage; rice; rice, straw; spinach; and sugarcane.

The established tolerances for green barley fodder, popcorn forage, and peanut hulls should be revoked since these item are no longer considered significant livestock feed items (Table 1, OPPTS GLN 860.1000).

The established tolerances for sweet corn and oat commodities should be moved to 180.183(b) as registered uses of disulfoton on sweet corn and oats are restricted to CA and ME, respectively.

Tolerances To Be Proposed Under 40 CFR §180.183(a):

Tolerances must be proposed for cowpea hay and field pea hay. The appropriate tolerance levels for these commodities will be determined when adequate field trial data have been submitted and evaluated. The registrant may elect to exclude use of disulfoton on cowpeas and field peas instead of proposing tolerances.

A tolerance must be proposed for aspirated grain fractions. Concentration factors were 10.3x, 2.66x, and 1.35x for field corn, sorghum, and wheat aspirated grain fractions, respectively. Reassessed tolerances were 0.3 ppm for field corn, 0.75 ppm for sorghum grain, and 0.2 ppm for wheat grain. Multiplying concentration factors by reassessed tolerances gives 3 ppm for corn, 2 ppm for sorghum, and 0.3 ppm for wheat. The tolerance for aspirated grain fractions will be the highest of these values, 3.0 ppm.

As a result of changes in Table 1 (GLN 860.1000), tolerances are now required for cotton gin byproducts and the hay of oats. The appropriate tolerance levels for these commodities will be determined when adequate field trial data have been submitted and evaluated. Once field trial data on wheat hay are consistent with maximum label rates, data for wheat hay will be translated to oat hay.

Tolerances Listed Under 40 CFR §180.183(b):

The tolerance currently listed under 40 CFR §180.183(b) is established with regional registration. Adequate data are available to reassess the established tolerance for asparagus.

Tolerances To Be Proposed Under 40 CFR §180.183(b):

The tolerances listed under 40 CFR §180.183(a) for sweet corn commodities (grain, forage, and fodder) and oat commodities (green fodder, grain, and straw) should be listed under 40 CFR 180.183(b) as use of disulfoton on these crops is restricted to CA and ME, respectively. A tolerance with regional registration must be proposed for oat hay.

Tolerances Listed Under 40 CFR §186.1950:

The tolerances listed under 40 CFR §186.1950 for sugar beet pulp and pineapple bran should be revoked as there are currently no Bayer-registered uses of disulfoton on sugar beets or pineapple.

Pending Tolerance Petitions:

PP#7F1895: The following tolerances for residues of disulfoton and its cholinesterase-inhibiting metabolites were proposed: green alfalfa (1 ppm); alfalfa hay (4 ppm); barley green fodder (1 ppm); barley straw (1 ppm); bean vines (2 ppm); bean vine hay (8 ppm); green clover (1 ppm); clover hay (4 ppm); corn forage (1 ppm); corn fodder (1 ppm); oat green fodder (1 ppm); oat straw (1 ppm); sorghum forage (1 ppm); sorghum fodder (1 ppm); wheat green fodder (1 ppm); wheat straw (1 ppm); milk (0.01 ppm); and the fat, meat, and meat byproducts of cattle, goats, hogs, horses, and sheep (0.05 ppm). No action has been taken on this petition since 1984.

Table C. Tolerance Reassessment Summary for Disulfoton.

Commodity	Current Tolerance, ppm	Tolerance Reassessment, ppm	Comment/ *[Correct Commodity Definition]*
Tolerances Listed Under 40 CFR §180.183(a)			
Alfalfa, fresh	5.0	Revoke	There are currently no Bayer-registered uses of disulfoton on alfalfa.
Alfalfa, hay	12.0	Revoke	
Barley, fodder, green	5.0	Revoke	No longer considered a significant livestock feed item (Table 1, OPPTS 860.1000).
Barley, grain	0.75	0.20	
Barley, straw	5.0	5.0	
Barley, hay	5.0	5.0	
Beans, dry	0.75	0.75	*[Bean, seed]*
Beans, lima	0.75		
Beans, snap	0.75	0.75	*[Bean, succulent]*
Beans, vines	5.0	TBD [1,2]	*[Cowpea, forage]*
Beets, sugar, roots	0.5	Revoke	There are currently no Bayer-registered uses of disulfoton on sugar beets.
Beets, sugar, tops	2.0	Revoke	
Broccoli	0.75	0.75	
Brussels sprouts	0.75	0.75	
Cabbage	0.75	0.75	
Cauliflower	0.75	0.75	
Clover, fresh	5.0	Revoke	There are currently no Bayer-registered uses of disulfoton on clover.
Clover, hay	12.0	Revoke	
Coffee beans	0.3	0.2	*[Coffee, bean, green]*
Corn, field, fodder	5.0	3.0	*[Corn, field, stover]*
Corn, field, forage	5.0	5.0	
Corn, grain	0.3	0.30	*[Corn, field, grain]*
Corn, pop	0.3	0.30	*[Corn, pop, grain]*
Corn, pop, fodder	5.0	3.0	*[Corn, pop, stover]*
Corn, pop, forage	5.0	Revoke	No longer considered a significant livestock feed item (Table 1, OPPTS 860.1000).
Corn, sweet, fodder	5.0	3.0	Tolerances must be moved to 180.183(b) as use is restricted to CA. *[Corn, sweet, stover]*
Corn, sweet, forage	5.0	5.0	
Corn, sweet, grain (K+CWHR)	0.3	0.30	*[Corn, sweet (K+CWHR)]*
Cottonseed	0.75	0.75	*[Cotton, undelinted seed]*

(continued; footnotes follow)

Table C *(continued)*.

Commodity	Current Tolerance, ppm	Tolerance Reassessment, ppm	Comment/ *[Correct Commodity Definition]*
Hops	0.5	Revoke	There are currently no Bayer-registered uses of disulfoton on hops.
Lettuce	0.75	0.75, head ≥ 2.0, leaf [3]	*[Lettuce, head]* *[Lettuce, leaf]*
Oats, fodder, green	5.0	5.0	*[Oats, forage]* Tolerances must be moved to 180.183(b) as use is restricted to ME.
Oats, grain	0.75	0.75	
Oats, straw	5.0	5.0	
Peanuts	0.75	0.10	*[Peanut, nutmeat]*
Peanuts, hay	5.0	5.0	*[Peanut, hay]*
Peanuts, hulls	0.3	Revoke	No longer considered a significant livestock feed item (Table 1, OPPTS 860.1000).
Peas	0.75	0.75	*[Pea, seed]* *[Pea, succulent]*
Peas, vines	5.0	TBD [2]	*[Pea, field, vines]*
Pecans	0.75	0.10	*[Pecan]*
Peppers	0.1	0.10	*[Pepper, bell]* *[Pepper, non-bell]*
Pineapples	0.75	Revoke	There are currently no Bayer-registered uses of disulfoton on pineapple.
Pineapples, foliage	5.0	Revoke	
Potatoes	0.75	0.50	*[Potato]*
Rice	0.75	Revoke	There are currently no Bayer-registered uses of disulfoton on rice.
Rice, straw	5.0	Revoke	
Sorghum, fodder	5.0	5.0	*[Sorghum, grain, stover]*
Sorghum, forage	5.0	5.0	*[Sorghum, grain, forage]*
Sorghum, grain	0.75	0.75	*[Sorghum, grain, grain]*
Soybeans	0.1	0.10	*[Soybean, seed]*
Soybeans, forage	0.25	0.25	*[Soybean, forage]*
Soybeans, hay	0.25	0.25	*[Soybean, hay]*
Spinach	0.75	Revoke	There are currently no Bayer-registered uses of disulfoton on spinach.
Sugarcane	0.3	Revoke	There are currently no Bayer-registered uses of disulfoton on sugarcane.
Tomatoes	0.75	0.75	*[Tomato]*
Wheat, fodder, green	5.0	5.0	*[Wheat, forage]*

(continued; footnotes follow)

Table C *(continued)*.

Commodity	Current Tolerance, ppm	Tolerance Reassessment, ppm	Comment/ *[Correct Commodity Definition]*
Wheat, grain	0.3	0.20	
Wheat, straw	5.0	5.0	
Tolerances Listed Under 40 CFR §180.183(b)			
Asparagus	0.1	0.10	
Tolerances Listed Under 40 CFR §186.1950			
Sugar beet pulp	5	Revoke	There are currently no Bayer-registered uses of disulfoton on sugar beets.
Pineapple bran	5	Revoke	There are currently no Bayer-registered uses of disulfoton on pineapple.
Tolerances to be Proposed Under 40 CFR §180.183(a)			
Aspirated grain fractions	--	3.0	
Cotton, gin byproducts	--	TBD	
Cowpea, hay	--	TBD [2]	
Pea, field, hay	--	TBD [2]	
Meat of cattle, hogs, horses, goats, and sheep	--	0.05	
Meat byproducts of cattle, hogs, horses, goats, and sheep	--	0.05	
Fat of cattle, hogs, horses, goats, and sheep	--	0.05	
Milk	--	0.01	
Tolerances to be Proposed Under 40 CFR §180.183(b)			
Oats, hay	--	TBD [4]	

[1] TBD = to be determined. Field residue data remain outstanding.

[2] The registrant may elect to exclude use of disulfoton on cowpeas and field peas. If use of disulfoton on cowpeas and field peas is not allowed, tolerances for cowpea forage and hay and field pea vines and hay are not required.

[3] Field residue data remain outstanding; however, the available data indicate that a separate, higher tolerance for leaf lettuce is required.

(continued; footnotes follow)

[1] Required field residue data for wheat hay will be used to determine appropriate tolerance levels for oat hay.

CODEX HARMONIZATION

The Codex Alimentarius Commission has established several maximum residue limits (MRLs) for residues of disulfoton in/on various raw agricultural commodities. The Codex MRLs are expressed in terms of the sum of disulfoton, demeton-S, and their sulphoxides and sulphones expressed as disulfoton. Codex MRLs and the U.S. tolerances will be compatible when the U.S. tolerance expression is revised to include disulfoton, its oxygen analog, and their sulfoxides and sulfones, calculated as disulfoton. A comparison of the Codex MRLs and the corresponding reassessed U.S. tolerances is presented in Table D.

The following conclusions can be made regarding efforts to harmonize U.S. tolerances with Codex MRLs: (i) compatibility between the U.S. tolerances and Codex MRLs exists for barley; coffee beans; maize fodder; peanut; pecan; potato; and sorghum forage (green); and (ii) incompatibility of the U.S. tolerances and Codex MRLs remains for asparagus, barley straw and dry fodder, beans (dry), broccoli, head cabbages, cauliflower, common bean (pods and/or immature seeds), cotton seed, garden pea (young pods), shelled garden pea, head and leaf lettuce, maize, maize forage, oat forage, oat straw and dry fodder, oats, sorghum, sweet corn (corn-on-the-cob), wheat forage (whole plant), and wheat straw and dry fodder because of differences in good agricultural practices. No questions of compatibility exist with respect to commodities where Codex MRLs have been established but U.S. tolerances do not exist or will be revoked.

(continued; footnotes follow)

Table D. Codex MRLs and applicable U.S. tolerances for disulfoton. Recommendations are based on conclusions following reassessment of U.S. tolerances (see Table C).

Codex			Reassessed U.S. Tolerance, ppm	Recommendation And Comments
Commodity, As Defined	MRL (mg/kg)	Step		
Alfalfa fodder	5	CXL	None	The U.S. tolerance will be revoked.
Asparagus	0.02 (*) [1]	7B	0.10	
Barley	0.2	7C(a)	0.20	Compatibility exists.
Barley straw and fodder, Dry	3	CXL	5.0	
Beans (dry)	0.05	7C	0.75	
Broccoli	0.1	7C	0.75	
Cabbages, Head	0.2	7C	0.75	
Cauliflower	0.05	7C	0.75	
Cereal grains (except rice and maize)	0.2	CXL	--	(See barley, oats, and wheat)
Chicken eggs	0.02 (*)	7B	--	No U.S. tolerance exists.
Clover hay or fodder	10	CXL	None	The U.S. tolerance will be revoked.
Coffee beans	0.2	CXL	0.20	Compatibility exists.
Common bean (pods and/or immature seeds)	0.2	7C	0.75	
Cotton seed	0.1	7C	0.75	
Forage crops (green) (except maize forage)	5	CXL	--	(See oat and wheat forage)
Garden pea (young pods)	0.1	7C	0.75	
Garden pea, Shelled	0.02 (*)	7B	0.75	
Lettuce, Head	1	7C	0.75	
Lettuce, Leaf	1	7C	≥ 2.0	
Maize	0.5	CXL	0.30	
Maize	0.01 [2]	7B(a)	0.30	
Maize fodder	3	CXL	3.0	Compatibility exists.
Maize forage	1	CXL	5.0	
Milk of cattle, goats, and sheep	0.01	7B	0.01	Compatibility exists.
Oat forage (green)	0.5	7C(a)	5.0	
Oat straw and fodder, Dry	0.05	7C	5.0	
Oats	0.02 (*)	7B(a)	0.75	

(continued; footnotes follow)

Table D (continued).

Codex			Reassessed U.S. Tolerance, ppm	Recommendation And Comments
Commodity, As Defined	MRL (mg/kg)	Step		
Peanut	0.1	CXL	0.10	Compatibility exists.
Pecan	0.1	CXL	0.10	Compatibility exists.
Pineapple	0.1	CXL	None	The U.S. tolerance will be revoked.
Potato	0.5	CXL	0.50	Compatibility exists.
Poultry meat	0.02 (*)	7B	--	No U.S. tolerance exists.
Radish, Japanese	0.2	CXL	--	No U.S. tolerance exists.
Rice	0.5	CXL	None	The U.S. tolerance will be revoked.
Sorghum	1	7C(a)	0.75	
Sorghum forage (green)	5	7C(a)	5.0	Compatibility exists.
Sugar beet	0.2	CXL	None	The U.S. tolerance will be revoked.
Sugar beet leaves or tops	2	CXL	None	The U.S. tolerance will be revoked.
Sweet corn (corn-on-the-cob)	0.02 (*)	7B	0.30	
Sweet corn (kernels)	0.02 (*)	7B	--	No U.S. tolerance exists (for kernels).
Vegetables (except as otherwise listed)	0.5	CXL	0.10 (peppers) 0.75 (tomatoes)	
Wheat	0.2	7C(a)	0.20	Compatibility exists.
Wheat forage (whole plant)	1	7C(a)	5.0	
Wheat straw and fodder, Dry	5	7C	5.0	Compatibility exists (for straw)

[1] (*) = At or about the limit of detection.
[2] The 1994 JMPR concluded that this MRL should not be designated as at the limit of determination.

DIETARY EXPOSURE ASSESSMENT

Anticipated residues have been determined for chronic dietary risk (CBRS 10904, 17923, 9/17/97, J. Abbotts).

(continued; footnotes follow)

Table D *(continued)*.

AGENCY MEMORANDA RELEVANT TO REREGISTRATION

CB Nos.:	366 and 367
Subject:	Disulfoton (Di-Syston) Reregistration - Evaluation of Applications for Revised Labels for Di-Syston 8 (EPA Registration No. 3125-307) and Di-Syston 15% Granular (EPA Registration No. 3125-173) Re: Waiver of Residue Chemistry Data
From:	M. Firestone
To:	G. LaRocca and A. Rispin
Dated:	3/13/86
MRID(s):	None

CB No.:	1394
Subject:	TX860007: Section 24(c) registration for DI-SYSTON 8 on cotton.
From:	F. Suhre
To:	G. LaRocca/J. Shell
Dated:	9/24/86
MRID(s):	00162859

CB No.:	1499
Subject:	NC860005. Disulfoton (Di-Syston): 24(c) Registration on Asparagus in North Carolina
From:	W. Anthony
To:	G. LaRocca
Dated:	12/2/86
MRID(s):	None

CB No.:	1688
Subject:	NC860005. Disulfoton (DI-SYSTON 8EC, EPA Reg. No. 3125-307) on Asparagus. 24(c) Special Local Needs Registration.
From:	M. Metzger
To:	G. LaRocca
Dated:	12/10/86
MRID(s):	40005301

CB No.: 1961
Subject: NC860005. Disulfoton (DI-SYSTON 8EC. EPA Reg. No. 3125-307) on Asparagus. 24(C) Special Local Needs Registration.
From: M. Metzger
To: G. LaRocca/J. Shell
Dated: 4/15/87
MRID(s): None

CB No.: 2510
Subject: ID# WY-870004 Disulfoton [DI-SYSTON-8]: 24(c) on Triticale in Wyoming
From: W. Anthony
To: G. LaRocca
Dated: 7/31/87
MRID(s): None

CB No.: 3881
Subject: ME-880001, 24(c) Registration for Di-syston in or on Oats.
From: W. Chin
To: G. LaRocca
Dated: 6/23/88
MRID(s): None

CB No.: 4226
Subject: Disulfoton Registration Standard Follow Up. DEB Comments on Mobay Letter Dated July 20, 1988.
From: S. Willett
To: G. LaRocca and R. Engler
Dated: 10/6/88
MRID(s): None

CB No.: 4818
Subject: Response to the Guidance Document for Disulfoton, and Agency's Letter of July 30, 1987 to Mobay Corporation; Nature of the Residues in Livestock Commodities.
From: H. Fonouni
To: G. LaRocca
Dated: 3/30/89
MRID(s): 40939001 and 40939002

CB No.:	None
Subject:	Metabolism Peer Review Committee Meeting on Disulfoton
From:	R. Schmitt
To:	G. LaRocca
Dated:	8/17/89
MRID(s):	None

CB No.:	8435
DP Barcode:	D167836
Subject:	TX860007. 24(c) Amended Registration for Di-Syston 8 (EPA Reg. No. 3125-307) for use in or on cotton.
From:	D. McNeilly
To:	T. Lemaster
Dated:	9/6/91
MRID(s):	None

CB Nos.:	8354, 8355, and 8356
DP Barcodes:	D167312, D167316, and D167317
Subject:	DI-SYSTON (Disulfoton). Impact of Craven Analytical Data on Registrations.
From:	M. Flood
To:	G. LaRocca
Dated:	9/18/91
MRID(s):	None

DP Barcode:	D157584
Subject:	EFGWB Review of Confined Rotational Crop and Limited Rotational Crop Studies.
From:	A. Abramovitch
To:	L. Rossi, R. Bright, K. Samek
Date:	2/12/92
MRID(s):	40120601 and 40120602

CBTS No.:	10141
Subject:	VA920006. Di-Syston 15% Granular for in-furrow use at planting on peanuts.
From:	S. Knizner
To:	T. Lemaster
Dated:	7/23/92
MRID(s):	None

CBTS No.:	10947
DP Barcode:	D185316
Subject:	CA920025; Section 24(c), Disulfoton, (Di-Syston 8, EPA Reg. No. 3125-307) in or on bermuda grass grown for seed.
From:	W. Wassell
To:	G. LaRocca/T. Lemaster
Dated:	12/18/92
MRID(s):	None

CB No.:	None
DP Barcode:	None
Subject:	Disulfoton in/on Immature Cotton Grown from Treated Seed. Evaluation of Plant Metabolism and Estimation of Residue Levels.
From:	D. Davis
To:	D. Edwards
Dated:	9/2/93
MRID(s):	None

CBRS No.:	11339
DP Barcode:	D187260
Subject:	Disulfoton. CBRS Comments on Proposed Protocol for Pyrolysis Study.
From:	D. Miller
To:	PM Team 72
Dated:	9/10/93
MRID(s):	None

CBRS No.:	12817
DP Barcode:	D196216
Subject:	Disulfoton. Nature of the Residue Study on Tobacco.
From:	D. Miller
To:	S. Jennings
Dated:	11/24/93
MRID(s):	42850201

CBRS No.:	None
DP Barcode:	None
Subject:	Disulfoton. Response to 48 Hour Review Request.
From:	D. Miller
To:	S. Jennings
Dated:	6/23/94
MRID(s):	None

CBTS No.:	15111
DP Barcode:	D212168
Subject:	Evaluation of Washington State Department of Agriculture Request for Nonfood/Nonfeed Status for Small-Seeded Vegetable Seed Crops.
From:	B. Schneider
To:	S. Johnson
Dated:	2/14/95
MRID(s):	None

CBRS No.:	17659
DP Barcode:	D231360
Subject:	Disulfoton (032501), Reregistration Case 102. Registrant Bayer Corporation. Guideline 860.1000. Tobacco Pyrolysis.
From:	J. Abbotts
To:	P. Deschamp
Dated:	3/7/97
MRID(s):	44146503

CBRS Nos.:	13715, 17656, and 17657
DP Barcodes:	D203210, D231362, and D231369
Subject:	Disulfoton (032501), Reregistration Case 102. Registrant Bayer Corporation. Guideline 860.1300, Nature of the Residue, Plants.
From:	J. Abbotts

To:	P. Deschamp
Dated:	3/18/97
MRID(s):	43222401-43222404, 44146501, and 44146502

CBRS No.:	17869
DP Barcode:	D235210
Subject:	Disulfoton (032501), Reregistration Case No. 0102. Issues to be presented at the 4/21/97 meeting of the HED Metabolism Committee.
From:	J. Abbotts
To:	HED Metabolism Committee
Dated:	4/15/97
MRID(s):	None

CBRS Nos.:	14708 and 17253
DP Barcodes:	D209425 and D226575
Subject:	Disulfoton (032501), Reregistration Case 102. Registrant Bayer Corporation. Guideline 860.1850, Confined Rotational Crops. Guideline 860.1900, Field Rotational Crops. Guideline 860.1380, Storage Stability.
From:	J. Abbotts
To:	J. Smith
Dated:	4/16/97
MRID(s):	43447701-43447705 and 43957301

CBRS No.:	17887
DP Barcode:	D235406
Subject:	Results of the HED Metabolism Committee Meeting Held on 4/21/97: Disulfoton in Plants.
From:	J. Abbotts
To:	HED Metabolism Committee
Dated:	5/1/97
MRID(s):	None

CBRS No.:	17898
DP Barcode:	D235170
Subject:	Disulfoton (032501), Reregistration Case 102. Registrant Bayer Corporation. Guideline 860.1520. Potato Processing. Guideline 860.1380. Storage Stability, Potato Commodities.
From:	J. Abbotts

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To:	P. Deschamp
Dated:	5/14/97
MRID(s):	44248004 and 44248005

CBRS No.:	17897
DP Barcode:	D235168
Subject:	Disulfoton (032501), Reregistration Case 102. Registrant Bayer Corporation. Guideline 860.1500. Field Trial Data, Cereal Grains. Guideline 860.1520. Processing Studies, Cereal Grains.
From:	J. Abbotts
To:	P. Deschamp
Dated:	5/22/97
MRID(s):	44248007, 44248009, and 44248010

CBRS No.:	17896
DP Barcode:	D235166
Subject:	Disulfoton (032501), Reregistration Case 102. Registrant Bayer Corporation, Response to DCI. Residue Chemistry Guidelines (Series 860).
From:	J. Abbotts
To:	P. Wagner
Dated:	6/18/97
MRID(s):	44248001

CBRS No.:	17899
DP Barcode:	D235171
Subject:	Disulfoton (032501), Reregistration Case 102. Registrant Bayer Corporation. Guideline 860.1500. Field Trial Data, Lettuce. Guideline 860.1520. Processing, Coffee and Cotton.
From:	J. Abbotts
To:	P. Wagner
Dated:	7/8/97
MRID(s):	44248003, 44248006, and 44248008

DP Barcode:	D238139
Subject:	Disulfoton (032501), Reregistration Case 102. Registrant Bayer Corporation. Guideline 860.1000. Tobacco Pyrolysis.
From:	J. Abbotts
To:	D. Anderson and D. Lateulere

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Dated: 9/23/97
MRID(s): 44301901

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1967. (Compilation; unpublished study received Feb 3, 1969 under 3125-119; CDL:101732-A)

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/OPP #

APPENDIX 5
Occupational/Residential Exposure Chapter for Disulfoton

Jonathan Becker

and

Memorandum from Jerome Blondell to Jonathan Becker of HED (3/25/1998), Review of Disulfoton Incidence Reports

Jerome Blondell

Anderson

21 May 1998

MEMORANDUM

SUBJECT: OCCUPATIONAL AND RESIDENTIAL EXPOSURE ASSESSMENT AND RECOMMENDATIONS FOR THE REREGISTRATION ELIGIBILITY DECISION DOCUMENT FOR DISULFOTON

FROM: Jonathan Becker, Ph.D., Environmental Health Scientist
Reregistration Branch 2
Health Effects Division (7509C)

TO: Phillip Poli
Reregistration Branch 3
Special Review and Reregistration Division (7508W)

THRU: Al Nielsen, Senior Scientist
Reregistration Branch 2
Health Effects Division (7509C)

Please find attached the occupational and residential review of disulfoton.

DP Barcode:	238096
Pesticide Chemical Codes:	032501
EPA Reg Nos.:	4-153, 4-253, 192-74, 192-126, 239-2134, 264-464, 400-408, 400-411, 400-475, 572-346, 769-850, 769-908, 802-426, 869-76, 69-223, 2935-435, 3125-83, 3125-116, 3125-172, 3125-183, 3125-307, 5481-415, 5887-61, 8660-125, 9688-94, 11474-70, 32802-32, 33955-489, 34704, 475, 34704-586, 28293-277, 42057-51, 46260-2, 46260-10, 49585-28, 59144-23, CA 92002500, CA 960014, NC 92001100, OR 91002700, TX 90000400, VA 92000600, WA 92002600
EPA MRID No.:	404690-01, 405041-05, and 422294-01
PHED:	Yes, Version 1.1

OCCUPATIONAL AND RESIDENTIAL EXPOSURE AND RISK ASSESSMENTS

(RED SECTION III, PART 3)
EXPOSURE AND RISK ASSESSMENT/CHARACTERIZATION

(BACKGROUND)

Purpose

In this document, which is for use in EPA's development of the Disulfoton Reregistration Eligibility Decision Document (RED), EPA presents the results of its review of the potential human health effects of occupational and residential exposure to disulfoton.

Criteria for Conducting Exposure Assessments

An occupational and/or residential exposure assessment is required for an active ingredient if (1) certain toxicological criteria are triggered and (2) there is potential exposure to handlers (mixers, loaders, applicators, etc.) during use or to persons entering treated sites after application is complete. For disulfoton, both criteria are met.

Summary of Toxicity Concerns Relating to Occupational and Residential Exposures

Acute Toxicology Categories

Table 1 below presents the acute toxicity categories based on the active ingredient as outlined in the Hazard Identification document.[1]

Table 1: Acute Toxicity Categories for Disulfoton

Guideline Number	Toxicity Category	MRID Number	Results	Toxicity Category
81-1	acute oral	Acc 072293 Doc 003958 P41	LD_{50}= M: 6.2 mg/kg F: 1.9 mg/kg	I
81-2	acute dermal	Acc 07793 Doc # 03958 P71 & 004223, p.24	LD_{50}= M: 15.9 mg/kg F: 3.6 mg/kg	I
81-3	acute inhalation	Acc 258569 Doc # 05789	LC_{50}= M: 0.06 mg/L F: 0.89 mg/L	I
81-4	primary eye irritation	Data requirement waived. Doc # 03958 p. 12: 004223. p14		
81-5	primary dermal irritation	Data requirement waived. Doc # 03958 p. 12: 004223. p14		
81-6	dermal sensitization	Data requirement waived. Doc # 03958 p. 12:		
81-8	acute neurotoxicity	42755801	Reversible neurotoxic signs consistent with the cholinesterase inhibition. 1.5 mg/kg in females and 5.0 mg/kg in males	

Other Endpoints of Concern

The Hazard Identification document for disulfoton, indicates that there are toxicological endpoints of concern. The endpoints used in assessing the risks for disulfoton are presented in the following Table 2.

Table 2: Endpoints for Assessing Occupational and Residential Risks for Disulfoton[1]

Test	Results
Short-term Dermal Exposure (1 to 7 days)	0.4 mg/kg/day (MOE = 100) based on a 21 day dermal study in rabbits
Intermediate-term Dermal Exposure (1 week to several months)	0.03 mg/kg/day (MOE = 100) based on a special 6 month cholinesterase inhibition feeding study
Inhalation Exposure (All-time periods)	0.00016 mg/L MOE = 100
Dermal Absorption	36%
Inhalation Absorption	100%

SUMMARY OF USE PATTERN AND FORMULATIONS

Occupational-Use and Homeowner-Use Products

At this time products containing disulfoton are intended for both homeowner and occupational uses. Residential uses include small vegetable gardens, ornamental flowers and shrubs including rose bushes and small trees and potted plants (indoor and outdoor). Occupational registrations include terrestrial food and feed crops, indoor greenhouse non-food crops, forest trees, ornamental herbaceous plants, ornamental woody shrubs and vines, ornamental shade trees.[2,3]

Type of pesticide/target pests

Disulfoton, (O,O-Diethyl S-[2-(ethylthio)ethyl] phosphorodithioate) is a selective systemic organophosphate insecticide used to control a variety of sucking insects. Examples of the type of insects that disulfoton controls include (but are not limited to) the following:[3]

- Vegetables and Field Crops: Aphids, Leafhoppers, Mexican bean beetle larvae, Mites, Thrips and Potato psyllid, Grasshoppers, Flea beetles, Southern potato wireworms, Root aphids, Green peach aphids, Colorado potato beetles, Hessian fly
- Ornamental shrubs, trees and rose bushes: Aphids, Birch leaf miner, Elm leaf beetle, European elm scale, Lace bug, Leafhoppers, Mites, Thrips, Whiteflies, Birch leafminers,

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Camellia scale, Holly leafminer, Leafhoppers, Mimosa webworm, Pine tip moth, Soft scale, Spider mites, Tea scale, Thrips and Whiteflies

Formulation types and percent active ingredient

Disulfoton is formulated as a technical product (98.5 percent active ingredient), an emulsifiable concentrate (85, 23, and 17.5 percent active ingredient), and as a granular (15, 10, 6.5, 2, 1, 0.625, 0.5, and 0.37 percent active ingredient). It is often formulated in combination with fertilizers.

Registered use sites[2,3]

Occupational-use sites

Disulfoton has been registered for occupational-use on agricultural crops, ornamental flowers and shrubs, non-bearing fruit trees, and nut trees. The occupational crops use sites in this RED have been grouped as follows:

- **Agricultural Crops (food and feed crops),** including peppers, broccoli, Brussel sprouts, cabbage, chinese cabbage, cauliflower, lettuce, spinach, asparagus, radishes, black and red raspberries, tomatoes, barley, field corn, oats, triticale, wheat, cotton, peanuts, peas, sorghum, soybeans, white/irish potatoes, dried, lima, and snap beans, lentils, sweet corn, sugar beets and popcorn and strawberries (propagating plants only) and tobacco;

- **Nut Trees,** specifically pecans growing in the south central and southwestern regions of the United States;

- **Non-Bearing Fruit Trees,** including apples, crabapples, pears, apricots, cherries, peaches, plums and prunes. Disulfoton is not applied to trees that will bear fruit during the current crop year;

- **Ornamental Flowers/Groundcover,** including annuals and bulbs;

- **Ornamental Shrubs and Trees,** including Christmas trees;

- **Potted Plants,** both indoor and outdoor.

Non-occupational-use sites

Potential residential and non-occupational use sites may include indoor or outdoor residential sites (e.g., exposure to insecticide use on ornamentals), professional uses at residential sites (e.g., insecticide use on trees, shrubs, and other ornamentals), and professional sites where non-occupational exposure may occur (ornamental trees, parks, residential and recreational areas). The non-occupational crops use sites in this RED have been grouped as follows:

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- **Residential Ornamental Flowers**, including annuals such as ageratum, calendulas, carnations, chrysanthemums, delphiniums, marigolds, petunias, snapdragons, zinnias, and bulbs;

- **Residential Ornamental Shrubs and Trees**, both evergreen and deciduous;

- **Residential Rose Bushes;**

- **Residential Vegetable Gardens**, including green, snap, and lima beans, Brussel sprouts, broccoli, cabbage, cauliflower, lettuce and peas; and

- **Residential Potted Plants**, both indoor and outdoor.

Application Rates[2,3]

- **Agricultural Crops**: The application rate for commercial crops ranges from 8 lb active ingredient (ai)/acre to 0.5 lb ai/acre, including rates of 1.0 lb ai/acre for crops such as broccoli, Brussel sprouts, cabbage and cauliflower, 2.0 lb ai/acre for lettuce, peppers, peanuts, 2.5 lb ai/acre for peas and lentils, and 4 lb ai/acre for tobacco and potatoes.

- **Nut Trees**: The maximum application rate for nut trees (i.e., pecan trees in the southern regions of the United States) is 3 lb ai/acre.

- **Non-Bearing Fruit Trees**: The application rate for pecan trees is 0.16 to 1.56 lb per tree (EPA Reg No. 3125-172). Based on the assumption of tree plantings with 10 foot centers, (435 trees/acre), the maximum application rate to non-bearing fruit trees is therefore 102 lb ai/acre.

- **Ornamental Flowers/Groundcover**: The maximum application rate is 28.6 lb ai/acre.

- **Shrubs and Trees**: (including Christmas trees): Based on the assumption of plantings using 10 foot centers, and 2-inch trunk diameters (when measured at a height of 4 feet), the application rate to trees is 20 lb ai/acre. The application rate to shrubs is 4.3 lb ai/acre, assuming 4 foot shrub height, and 435 shrubs/acre.

- **Potted Plants**: The application rate for granular hand method applications to potted plants is 0.00052 lb ai/12 inch pot.

- **Residential Ornamental Flowers**: The maximum application rate ranges from 0.3 lb ai/1,000 ft^2 to 0.005 lb ai/1,000 ft^2.

- **Residential Ornamental Shrubs and Small Trees**: The maximum application rates for granular applications range from 1.32 lb ai/four foot shrub or tree to 0.00032 lb ai/four foot shrub or tree.

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- **Residential Rose Bushes:** The maximum application rate for granular application to rose bushes is 0.00188 lb ai/bush.

- **Residential Vegetable Gardens:** The maximum application rate ranges from 0.1125 lb ai/1,000 ft^2 to 0.0313 lb ai/1,000 ft^2.

- **Residential Potted Plants:** The maximum application rate for hand application of granulars to pots is 0.00011 lb ai/six inch pot.

Methods and Types of Equipment used for Mixing, Loading, and Application[2,3]

Disulfoton can be applied with ground or air equipment using broadcast, chemigation, high volume spray, low volume spray, seed treatment, soil band treatment, soil incorporated broadcast treatment, soil in-furrow treatment (drill and hill-drop), top dressing equipment, soil injection, soil sidedress, and by hand using a shaker can, spoon, or measuring scoop. Following application, disulfoton is soil incorporated into the top 2 to 3 inches of soil and may require watering in.

- **Agricultural Crops:** Granular formulations are typically applied in the seed furrow or in a soil incorporated band on each side of the seed furrow at planting. When used as a preplanting treatment, disulfoton is applied using broadcast granular and liquid spray equipment and then soil incorporated into the top 2 to 3 inches of soil. Examples include: for cotton, disulfoton granules are applied as a soil in furrow treatment applied over seed at planting or in a soil incorporated band on each side of the furrow which is then soil incorporated; for sorghum, applications are made at planting, and then into the whorl post planting; and for barley, drilling or broadcast at planting and broadcast after emergence.

- **Nut Trees** (specifically pecans grown in states of the South Central and Southwestern regions): Granulars are applied by treating 6 foot bands of soil on both sides of the trees, followed by soil incorporation into top 2 to 3 inches of soil and then watered in.

- **Non-Bearing Fruit Trees:** Granulars are applied uniformly from trunk to drip line on all sides, soil incorporated and watered in.

- **Flowers/Groundcover:** As a preplant treatment, granular formulations can be evenly applied to seed beds by hand or belly grinder, and then soil incorporated.

- **Shrubs and Trees:** (including Christmas trees) Application is made by soil injection or soil implantation with an auger or soil sampling tool: Granules are applied as a soil incorporated broadcast treatment, or evenly spread under shrub canopy, and then soil incorporated.

- **Potted Plants:** Applications are made by hand, and then soil incorporated.

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- **Residential Ornamental Flowers:** Belly grinder applications can be used for preplanting treatment, or treatments can be applied by hand using a spoon, measuring cup, or shaker can, and then soil incorporated.

- **Residential Ornamental Shrubs:** Applications are made by distributing granules uniformly under the shrub canopy by hand using a spoon, measuring cup, or shaker can and soil incorporated and then watered in.

- **Residential Rose Bushes:** Belly grinder applications can be made for preplanting treatment. At planting, or to established bushes, application of granulars is made by hand using a spoon, measuring cup, or shaker can.

- **Residential Vegetable Gardens:** Belly grinder applications can be made for preplanting treatment. At planting, or to established shrubs or trees, application of granulars is made by hand using a spoon, measuring cup, or shaker can.

- **Residential Potted Plants:** Applications are made by hand by punching a hole into soil and pouring granules into the holes or sprinkling granules on the soil and soil incorporating.

ASSESSMENT/CHARACTERIZATION

Occupational Exposures and Risks

Handler Exposures & Risks

EPA has determined that there are potential exposures to mixers, loaders, applicators, or other handlers during usual use-patterns associated with disulfoton. Based on the use patterns, 15 major exposure scenarios were identified for disulfoton: (1a) mixing, loading liquid formulations (emulsifiable concentrates) for aerial/chemigation application; (1b) mixing, loading liquid formulations (emulsifiable concentrates) for groundboom application; (1c) mixing, loading liquid formulations (emulsifiable concentrates) for orchard airblast sprayer application; (2a) loading granulars for aerial application; (2b) loading granulars for tractor-drawn spreader application; (3) applying sprays with a fixed-wing aircraft; (4) applying granulars with a fixed-wing aircraft; (5) applying sprays with a helicopter; (6) applying granulars with a helicopter; (7) applying sprays with a groundboom; (8) applying sprays to orchards with an airblast; (9) applying granulars with a tractor-drawn spreader; (10) loading and applying granulars using a belly grinder; (11) loading and applying granulars with a push-type granular spreader; (12) applying granulars by hand, with a spoon, shaker can, or a measuring scoop; (13) applying ready-to-use liquid as a seed soak treatment; (14) flagging during aerial spray applications; and (15) flagging during aerial granular applications.

Handler Exposure Scenarios -- Data and Assumptions

An exposure assessment for each scenario was developed, where appropriate data are available, using the *Pesticide Handlers Exposure Database (PHED) Version 1.1.*[4] Table 3

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summarizes the caveats and parameters specific to the surrogate data used for each scenario and corresponding exposure/risk assessment. These caveats include the source of the data and an assessment of the overall quality of the data. The assessment of data quality is based on the number of observations and the available quality control data. The quality control data are based on a grading criteria established by the PHED task force.

The following assumptions and factors were used in order to complete this exposure assessment:

- Average body weight of an adult handler is 70 kg.
- Average work day interval represents an 8 hour workday (e.g., the acres treated or volume of spray solution prepared in a typical day are based on an 8 hour workday).
- Daily acres and volumes (as appropriate) to be treated in each scenario include:
  - 350 acres for aerial and chemigation applications in agricultural settings (including flaggers supporting aerial applications)
  - 80 acres for groundboom spraying of agricultural areas
  - 80 acres for tractor-drawn spreader application to agricultural settings
  - 40 acres for orchard airblast application
  - 2 acres for application of granular formulations to orchards and ornamental flower or groundcover nursery stock using a tractor-drawn spreader
  - 2 acres for application of granular formulations to agricultural fields using a belly grinder
  - 350 pots (12 inch diameter) treated when applying and soil incorporating granulars by hand with a spoon, shaker can, or a measuring scoop
- Calculations are completed at the maximum application rates for specific crops recommended by the available disulfoton labels to bracket risk levels associated with the various use patterns.
- Due to a lack of scenario-specific data, HED is often forced to calculate unit exposure values using generic protection factors (PF) that are applied to represent various risk mitigation options (i.e., the use of Personal Protective Equipment (PPE) and engineering controls). PPE protection factors include those representing a double layer of clothing (50 percent PF), chemical resistant gloves (90 percent PF) and respiratory protection (80 percent PF) for use of dust/mist mask. Engineering controls are generally assigned a PF of 98 percent.

Handler Exposure and Non-Cancer Risk Estimates

Handler exposure assessments are completed by EPA using a baseline exposure scenario and, if required, increasing levels of risk mitigation (PPE and engineering controls) to achieve an appropriate margin of exposure (MOE). The baseline scenario generally represents a handler wearing long pants, a long-sleeved shirt, and no chemical-resistant gloves. The following tables

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present risk assessment calculations for the handling of disulfoton. Table 4 presents the short-term and intermediate-term dermal, and inhalation exposures at baseline. Table 5 presents the dermal and inhalation risks for those scenarios at baseline. Table 6 presents the occupational short-term and intermediate-term doses and risks when wearing PPE risk mitigation. Table 7 presents the same dose/risk calculations when employing engineering controls (e.g., enclosed cab or cockpit, and packaging for closed loading of granulars).

The calculations of daily dermal and inhalation exposure to disulfoton by handlers are used to calculate the daily dose and hence the risks, to those handlers. Potential daily dermal exposure is calculated using the following formula:

$$\text{Daily Dermal Exposure}\left(\frac{\text{mg ai}}{\text{day}}\right) = \text{Unit Exposure}\left(\frac{\text{mg ai}}{\text{lb ai}}\right) \times \text{Use Rate}\left(\frac{\text{lb ai}}{A}\right) \times \text{Daily Acres Treated}\left(\frac{A}{\text{day}}\right)$$

The potential short-term and intermediate-term dermal doses were calculated using the following formulae:

$$\text{Short-term Daily Dermal Dose}\left(\frac{\text{mg ai}}{\text{kg/day}}\right) = \text{Short-term Daily Dermal Exposure}\left(\frac{\text{mg ai}}{\text{day}}\right) \times \left(\frac{1}{\text{Body Weight (kg)}}\right)$$

$$\text{Intermediate-term Daily Dermal Dose}\left(\frac{\text{mg ai}}{\text{kg/day}}\right) = \text{Intermediate-term Daily Dermal Exposure}\left(\frac{\text{mg ai}}{\text{day}}\right) \times \left(\frac{1}{\text{Body Weight (kg)}}\right)$$

The short-term and intermediate-term dermal MOEs were calculated using the following formulae:

$$\text{Short-term Dermal MOE} = \frac{\text{Short-term NOEL}\left(\frac{\text{mg}}{\text{kg/day}}\right)}{\text{Short-term Dermal Daily Dose}\left(\frac{\text{mg}}{\text{kg/day}}\right)}$$

$$\text{Intermediate-term Dermal MOE} = \frac{\text{Intermediate-term NOEL}\left(\frac{\text{mg}}{\text{kg/day}}\right)}{\text{Intermediate-term Dermal Daily Dose}\left(\frac{\text{mg}}{\text{kg/day}}\right)} \times \text{Dermal Absorption Factor}$$

The short-term MOEs were calculated using a NOEL of 0.4 mg/kg/day assuming 100 percent dermal absorption. The intermediate-term MOEs were calculated using a NOEL of 0.03 mg/kg/day assuming 36 percent dermal absorption.

Potential daily inhalation exposure was calculated using the following formula:

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$$\text{Daily Inhalation Exposure}\left(\frac{\text{mg ai}}{\text{day}}\right) =$$
$$\text{Unit Exposure}\left(\frac{\mu\text{g ai}}{\text{lb ai}}\right) \times \text{Conversion Factor}\left(\frac{1\text{ mg}}{1{,}000\ \mu\text{g}}\right) \times \text{Use Rate}\left(\frac{\text{lb ai}}{A}\right) \times \text{Daily Acres Treated}\left(\frac{A}{\text{day}}\right)$$

The potential short-term and intermediate-term inhalation doses were calculated using the following formulae:

$$\text{Short-term Daily Inhalation Dose}\left(\frac{\text{mg ai}}{\text{kg/day}}\right) = \text{Short-term Daily Inhalation Exposure}\left(\frac{\text{mg ai}}{\text{day}}\right) \times \left(\frac{1}{\text{Body Weight (kg)}}\right)$$

$$\text{Intermediate-term Daily Inhalation Dose}\left(\frac{\text{mg ai}}{\text{kg/day}}\right) = \text{Intermediate-term Daily Inhalation Exposure}\left(\frac{\text{mg ai}}{\text{day}}\right) \times \left(\frac{1}{\text{Body Weight (kg)}}\right)$$

For disulfoton, the inhalation doses were calculated using a 70 kg body weight and an inhalation absorption rate of 100 percent.

The short-term and intermediate-term inhalation MOEs were calculated using the following formulae:

$$\text{Inhalation MOE} = \frac{\text{NOEL}\left(\frac{\text{mg}}{\text{kg/day}}\right)}{\text{Inhalation Daily Dose}\left(\frac{\text{mg}}{\text{kg/day}}\right)}$$

Both short-term and intermediate-term inhalation MOEs were calculated using a NOEL of 0.045 mg/kg/day (assuming 100% inhalation absorption) for both short-term and intermediate-term inhalation toxicity. The inhalation NOEL of 0.00016 mg/L was based on a study using Fisher rats. This concentration was converted to a dose (mg/kg/day) using respiratory volume of 7.15 liters/hour and a body weight of 0.152 kg.

The inhalation and dermal MOEs were calculated using the following formulas:

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$$\text{Dermal MOE} = \frac{\text{NOEL}\left(\frac{mg}{kg/day}\right)}{\text{Dermal Daily Dose}\left(\frac{mg}{kg/day}\right)}$$

$$\text{Inhalation MOE} = \frac{\text{NOEL}\left(\frac{mg}{kg/day}\right)}{\text{Inhalation Daily Dose}\left(\frac{mg}{kg/day}\right)}$$

The total MOE was calculated using the following formula:

$$\text{Total MOE} = \frac{1}{\left(\frac{1}{MOE_{dermal}}\right) + \left(\frac{1}{MOE_{inhalation}}\right)}$$

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Table 3: Exposure Scenario Descriptions for the Use of Disulfoton

Exposure Scenario (Number)	Data Source	Standard Assumptions[a] (8-hr work day)	Comments[b]
Mixer/Loader Descriptors			
Mixing/Loading Liquid Formulations (Emulsifiable Concentrates) (1a/1b/1c) (H)all	**PHED V1.1**	**350 acres for aerial and chemigation in agricultural settings, 80 acres for groundboom application, and 40 acres for orchard airblast applications**	**Baseline:** Hands, dermal, and inhalation = AB grades. Hands = 53 replicates; dermal = 72 to 122 replicates; and inhalation = 85 replicates. High confidence in hands, dermal and inhalation data. No protection factor was needed to define the unit exposure value. **PPE:** The same dermal data are used as for the baseline coupled with a 50% protection factor to account for an additional layer of clothing. A 5-fold PF (e.g. 80% PF was applied to the baseline inhalation data to account for the use of a dust mist respirator. Hands = AB grades with 59 replicates. High confidence in hands, dermal data. **Engineering Controls:** Mechanical transfer method. Hands, dermal and inhalation unit exposures = AB grades. Hands = 31 replicates; dermal = 16 to 22 replicates, and inhalation = 27 replicates. High confidence in dermal, hand and inhalation data. Gloves were worn during the use of the engineering controls.
Loading Granular Formulations (2a, 2b) (L) all except inhal (H)	**PHED V1.1**	**350 acres for aerial application, 80 acres for tractor drawn spreader agricultural application, and 2 acres for ornamental flowers/groundcover, and trees**	**Baseline:** Hands = All grade, dermal = ABC grade, and inhalation = AB grade. Hands = 10 replicates; dermal = 33 to 78 replicates; and inhalation = 58 replicates. Low confidence in dermal/ hand data. High confidence in inhalation data. **PPE:** Hands = AB grade, dermal = ABC grade. Dermal = 45 replicates, hands = 12-59 replicates. Low confidence in dermal and hands data. A 5-fold PF was applied to the baseline inhalation data to account for the use of a dust mist respirator. **Engineering Controls:** Closed loading of granulars. 98% PF was applied to baseline data
Applicator Descriptors			
Applying Liquid Formulations (Emulsifiable Concentrates) with a Fixed-Wing Aircraft (3,4) Bas L a PPE - no data EC - M (Hinhale)	**PHED V1.1**	**350 acres for aerial**	**Baseline:** No data **PPE:** No data **Engineering Controls:** Hands = AB grade, dermal and inhalation = ABC grade. Medium confidence in hands/dermal and inhalation data. Hands = 34 replicates, dermal = 24-48 replicates, and inhalation = 23 replicates.
Applying Granulars with a Fixed-Wing Aircraft (4) Bas L - no data PPE - no data EC - L	**PHED V1.1**	**350 acres for aerial**	**Baseline:** No data **PPE:** No data **Engineering Controls:** Hands and inhalation - All grade, dermal - C grade. Hands = 4 replicates, inhalation = 13 replicates, and dermal = 0-13 replicates. Low confidence in all data.

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Table 3: Exposure Scenario Descriptions for the Use of Disulfoton (Continued)

Exposure Scenario (Number)	Data Source	Standard Assumptions[a] (8-hr work day)	Comments[b]
Applying Liquid Formulations (Emulsifiable Concentrations) with a Helicopter (5,6)	**PHED V1.1**	**350 acres for aerial**	**Baseline: No data** **PPE: No data** **Engineering Controls: Hands and inhalation = A grade, dermal = C grade. Low confidence in inhalation data, and extremely low confidence in hands and dermal data due to very low number of replicates. Hands = 2 replicates, dermal = 3 replicates, and inhalation = 3 replicates.**
Applying Granulars with a Helicopter (6)	**No Data**	**No Data**	**No Data**
Applying Sprays with a Groundboom (7)	**PHED V1.1**	**80 acres in agricultural applications**	**Baseline: Hand, dermal, and inhalation = AB grades. Hands = 29 replicates, dermal = 23 to 42 replicates, and inhalation = 22 replicates. High confidence in hand, dermal, and inhalation data.** **PPE: The same dermal and inhalation data are used as for the baseline coupled with a 50% protection factor to account for an additional layer of clothing, and an 80% PF to account for the use of a dust mist respirator, respectively. Hands data are ABC grades with 21 replicates. Medium confidence in hands, and dermal data.** **Engineering Controls: Hands and dermal = ABC grade, inhalation = AB grade. Hands = 16 replicates, dermal = 20-31 replicates, inhalation = 16 replicates. Medium confidence in hands and dermal data, and high confidence in inhalation data.**
Applying Sprays to Orchards with an Airblast (8)	**PHED V1.1**	**40 acres for orchard spraying**	**Baseline: Hand, dermal and inhalation are AB grade. Hands 22 replicates, dermal = 32 to 49 replicates, and inhalation = 47 replicates. High confidence in hand, dermal and inhalation data.** **PPE: Hands and dermal = AB grade. Hands = 18 replicates, dermal = 31 to 48 replicates. High confidence in hands and dermal data. A 5-fold (80% PF) was applied to baseline inhalation data to account for use of dust-mist respirator.** **Engineering Controls: Dermal = AB grade, inhalation = ABC grade, hands = AB grade. Low confidence in inhalation and dermal data. Inhalation = 9 replicates, dermal = 20-30 replicates, and hands = 20 replicates. A 90% PF was applied to gloved data to represent no gloved scenario.**

Table 3: Exposure Scenario Descriptions for the Use of Disulfoton (Continued)

Exposure Scenario (Number)	Data Source	Standard Assumptions[a] (8-hr work day)	Comments[b]
Applying Granulars with a Tractor-Drawn Spreader (9) BI - L all PPF = L EC - H	PHED V1.1	80 acres for agriculture and 2 acres for ornamental flowers / groundcover application	**Baseline:** Hands, dermal and inhalation = AB grades. Low confidence in hands, dermal and inhalation data. Hands = 5 replicates, dermal = 1-5 replicates and inhalation = 5 replicates. **PPE:** The same hand and dermal data are used as for the baseline coupled with a 90% PF to account for chemical resistant gloves, and a 50% PF to account for an additional layer of clothing, respectively. The same inhalation data are used as for the baseline coupled with an 80% PF to account for the use of a dust mist respirator. **Engineering Controls:** Hands, dermal and inhalation data are AB grades. Hands = 24 replicates, dermal = 27 to 30 replicates, and inhalation = 2-30 replicates. High confidence in hands, dermal and inhalation data.
Mixer/Loader/Applicator Descriptors			
Loading/Applying Granulars Using a Belly Grinder (10) BI - M PPF M EC - Not feasible	PHED V1.1	2 acres for agricultural and ornamental flowers / groundcover application	**Baseline:** Hands and dermal = ABC grades and inhalation = AB grade. Medium confidence in hands/dermal data and high confidence in inhalation data. Hands = 23 replicates, dermal = 29-45 replicates and inhalation = 40 replicates. **PPE:** = Gloved data for hands = ABC grade with 15 replicates. The dermal data are taken from the baseline coupled with a 50% protection factor to account for an additional layer of clothing. A 5-fold protection factor (80% PF) was applied to baseline inhalation data to account for use of dust mist respirator. **Engineering Controls:** Not feasible
Loading/Applying Formulation Using a Push-Type Granulars Spreader (11) BI - L PPE - L EC - not feasible	PHED V1.1	2 acres for agricultural, ornamental flowers/groundcover, shrubs and tree application	**Baseline:** Hand and dermal = C grades, and inhalation = B grade. Hand = 15 replicates, dermal = 0-15 replicates, and inhalation = 15 replicates. Low confidence in hand and dermal data, and high confidence in inhalation data. **PPE:** The same dermal and hand data are used as for the baseline coupled with a 50% protection factor to account for an additional layer of clothing and a 90% protection factor to account for the use of chemical resistant gloves. A 5-fold protection factor (80% PF) was applied to the inhalation data to account for use of dust mist respirator. **Engineering Controls:** Not feasible.

Table 3: Exposure Scenario Descriptions for the Use of Disulfoton (Continued)

Exposure Scenario (Number)	Data Source	Standard Assumptions[a] (8-hr work day)	Comments[b]
Loading/Applying Granulars by Hand, Shaker Can, or with a Measuring Spoon (12) BI - L; PPE - L EC - NA (PHED values for Granular Bait Dispersed by Hand used as a surrogate for these application methods)	PHED V1.1	350 pots	**Baseline:** Dermal and Inhalation = ABC grades, both with 16 replicates. Low confidence in dermal, and medium confidence in inhalation. Hand data back-calculated from gloved data, assuming 90% PF. **PPE:** Gloved data for hands = ABC grade with 15 replicates. The dermal data are taken from the baseline coupled with a 50% PF to account for an additional layer of clothing. Both a 80% PF (dust mist mask), and 90% PF (organic vapor respirator) were applied to baseline inhalation exposure values to account for the use of respective respirators. **Engineering Controls:** Not applicable.
Applying Ready-to-Use Liquid as a Seed Treatment (13)	PHED V1.1	No Data	No Data
Flagger Exposure			
Flagging Aerial Spray Applications (14) BI - H PPE - H EC - M	PHED V1.1	350 acres	**Baseline:** Hands, dermal and inhalation data = AB grades. High confidence in dermal, hands and inhalation. Hands = 30 replicates, Inhalation = 28 replicates, and dermal = 18-28 replicates. **PPE:** Dermal and hands = AB grade. Hands = 6 replicates, dermal = 18-28 replicates. Low confidence for dermal and hands data. A 50% PF was applied to baseline data to represent dust mist masks. **Engineering Controls:** Hands and dermal = ABC grade, inhalation = AB grade. Inhalation = 16 replicates, dermal = 16 replicates, and dermal = 20-31 replicates. Medium confidence in hands, dermal data, and high confidence in inhalation data. These data are based on groundboom enclosed cab data.
Flagging Aerial Granular Applications (15) BI - L PPE - L EC - H	PHED V1.1	350 acres	**Baseline:** Hands and dermal = ABC grades. Dermal = 16-20 replicates, and hands = 4 replicates. Dermal values based on total deposition data assuming 50% PF applied to no clothes values. Inhalation = E grade with 4 replicates. Low confidence in all values. **PPE:** Dermal value based on 50% PF over baseline to account for double layer of clothes. Hands values based on 90% PF over baseline to account for use of gloves, and inhalation values based on 50% PF over baseline to account for use of dust mist mask. **Engineering Controls:** Hands, dermal and inhalation = AB grades with high confidence. Hands = 24 replicates, dermal = 27 to 30 replicates and inhalation = 37 replicates. All data based on granular drop type tractor drawn spreader enclosed cab.

Table 3: Exposure Scenario Descriptions for the Use of Disulfoton (Continued)

Footnotes

a All *Standard Assumptions* are based on an 8-hour work day as estimated by HED.

b All handler exposure assessments in this document are based on the "Best Available" data as defined by the PHED SOP for meeting Subdivision U Guidelines (i.e., completing exposure assessments). Best available grades are assigned to data as follows: matrices with A and B grade data (i.e., Acceptable Grade Data) and a minimum of 15 replicates; if not available, then grades A, B and C data and a minimum of 15 replicates; if not available, then all data regardless of the quality (i.e., All Grade Data) and number of replicates. High quality data with a protection factor take precedence over low quality data with no protection factor. Generic data confidence categories are assigned as follows:

High = grades A and B and 15 or more replicates per body part
Medium = grades A, B, and C and 15 or more replicates per body part
Low = any run that included D or E grade data or has less than 15 replicates per body part.

Table 4. Occupational Handler Dermal and Inhalation Exposures to Disulfoton at Baseline

Exposure Scenario (Scenario #)	Baseline Dermal Unit Exposure[a] (mg/lb ai)	Baseline Inhalation Unit Exposure[b] (μg/lb ai)	Range of Application Rates[c] (lb ai/acre)	Crop Type or Target[d]	Amount Handled per Day[e]	Daily Dermal Exposure[f] (mg/day)	Daily Inhalation Exposure[g] (mg/day)
Mixer/Loader Exposure							
Mixing/Loading Liquid Formulations (Emulsifiable Concentrates) for Aerial/Chemigation Application (1a)	2.9	1.2	3 lb ai/acre (chemigation only)	Ag (potatoes)	350 acres	3,000	1.3
			1 lb ai/acre	Ag (barley)		1,000	0.42
			0.5 lb ai/acre	Ag (sorghum)		510	0.21
Mixing/Loading Liquid Formulations (Emulsifiable Concentrates) for Groundboom Application (1b)	2.9	1.2	4 lb ai/acre	Ag (potatoes)	80 acres	930	0.38
			1 lb ai/acre	Ag (wheat)		230	0.096
			0.5 lb ai/acre	Ag (sorghum)		120	0.048
Mixing/Loading Liquid Formulations (Emulsifiable Concentrates) for Orchard Airblast Sprayer Application (1c)	2.9	1.2	3 lb ai/acre	Ag (pecans)	40 acres	350	0.14
Loading Granulars for Aerial Application (2a)	0.0084	1.7	2 lb ai/acre	Ag (cotton)	350 acres	5.9	1.2
			1 lb ai/acre	Ag (barley)		2.9	0.60
Loading Granulars for Tractor-Drawn Spreader Application (2b)	0.0084	1.7	8 lb ai/acre	Ag (raspberries)	80 acres	5.4	1.1
			4 lb ai/acre	Ag (potatoes)		2.7	0.54
			1 lb ai/acre	Ag (cabbage)		0.67	0.14
			3 lb ai/acre	Nut Trees	2 acres	0.050	0.010
			102 lb ai/acre[h]	Non-Bearing Fruit Trees		1.7	0.35
			28.6 lb ai/acre	Flowers/Groundcover		0.48	0.097

Table 4. Occupational Handler Dermal and Inhalation Exposures to Disulfoton at Baseline (Continued)

Exposure Scenario (Scenario #)	Baseline Dermal Unit Exposure[a] (mg/lb ai)	Baseline Inhalation Unit Exposure[b] (μg/lb ai)	Range of Application Rates[c] (lb ai/acre)	Crop Type or Target[d]	Amount Handled per Day[e]	Daily Dermal Exposure[f] (mg/day)	Daily Inhalation Exposure[g] (mg/day)
Applicator Exposure							
Applying Sprays with a Fixed-Wing Aircraft (3)	No Data See Eng. Control	No Data See Eng. Control	1 lb ai/acre	Ag (barley)	350 acres	See Eng. C.	See Eng. C.
			0.5 lb ai/acre	Ag (sorghum)		See Eng. C.	See Eng. C.
Applying Granulars with a Fixed-Wing Aircraft (4)	No Data See Eng. Control	No Data See Eng. Control	2 lb ai/acre	Ag (cotton)	350 acres	See Eng. C.	See Eng. C.
			1 lb ai/acre	Ag (barley)		See Eng. C.	See Eng. C.
Applying Sprays with a Helicopter (5)	No Data See Eng. Control	No Data See Eng. Control	1 lb ai/acre	Ag (barley)	350 acres	See Eng. C.	See Eng. C.
			0.5 lb ai/acre	Ag (sorghum)		See Eng. C.	See Eng. C.
Applying Granulars with a Helicopter (6)	No Data See Eng. Control	No Data See Eng. Control	2 lb ai/acre	Ag (cotton)	350 acres	See Eng. C.	See Eng. C.
			1 lb ai/acre	Ag (barley)		See Eng. C.	See Eng. C.
Applying Sprays with a Groundboom (7)	0.014	0.74	4 lb ai/acre	Ag (potatoes)	80 acres	4.5	0.24
			1 lb ai/acre	Ag (wheat)		1.1	0.059
			0.5 lb ai/acre	Ag (sorghum)		0.56	0.03
Applying Sprays to Orchards with an Airblast (8)	0.36	4.5	3 lb ai/acre	Ag	40 acres	43	0.54
Applying Granulars with a Tractor-Drawn Spreader (9)	0.0099	1.2	8 lb ai/acre	Ag (raspberries)	80 acres	6.3	0.77
			4 lb ai/acre	Ag (potatoes)		3.2	0.38
			1 lb ai/acre	Ag (cabbage)		0.79	0.096
			3 lb ai/acre[h]	Nut Trees	2 acres	0.059	0.0072
			102 lb ai/acre[h]	Non-Bearing Fruit Trees		2.0	0.24

Table 4. Occupational Handler Dermal and Inhalation Exposures to Disulfoton at Baseline (Continued)

Exposure Scenario (Scenario #)	Baseline Dermal Unit Exposure[a] (mg/lb ai)	Baseline Inhalation Unit Exposure[b] (μg/lb ai)	Range of Application Rates[c] (lb ai/acre)	Crop Type or Target[d]	Amount Handled per Day[e]	Daily Dermal Exposure[f] (mg/day)	Daily Inhalation Exposure[g] (mg/day)
			28.6 lb ai/acre	Flowers/Groundcover		0.57	0.069
Mixer/Loader/Applicator Exposure							
Loading/Applying Granulars Using a Belly Grinder (10)	10	62	4 lb ai/acre	Ag (strawberries)	2 acres	80	0.50
			1 lb ai/acre	Ag (spinach)		20	0.12
			28.6 lb ai/acre	Flowers/Groundcover	2 acres	570	3.5
Loading/Applying Granulars with a Push-Type Granular Spreader (11)	2.9	6.3	3 lb ai/acre	Nut Trees	2 acres	17	0.038
			102 lb ai/acre[h]	Non-Bearing Fruit Trees		590	1.3
			20 lb ai/acre[i]	Shrubs/Trees (inc. Christmas Trees)		120	0.25
			4.3 lb ai/acre[i]			25	0.054
			4 lb ai/acre	Ag (strawberries)	2 acres	23	0.050
			1 lb ai/acre	Ag (spinach)		5.8	0.013
			28.6 lb ai/acre	Flowers/Groundcover	2 acres	170	0.36
Loading/Applying Granulars by Hand, with a Spoon, Shaker Can, or a Measuring Scoop (12)	100	470	0.00052 lb ai/12-inch pot	Potted Plants	350 pots	18	0.086
Applying Ready-To-Use Liquid as a Seed Treatment (13)	No Data	No Data	No Data	No Data	No Data	No Data	No Data
Flagger Exposure							
Flagging Aerial Spray Applications (14)	0.011	0.35	1 lb ai/acre	Ag	350 acres	3.9	0.12
			0.5 lb ai/acre			1.9	0.061

Table 4. Occupational Handler Dermal and Inhalation Exposures to Disulfoton at Baseline (Continued)

Exposure Scenario (Scenario #)	Baseline Dermal Unit Exposure[a] (mg/lb ai)	Baseline Inhalation Unit Exposure[b] (μg/lb ai)	Range of Application Rates[c] (lb ai/acre)	Crop Type or Target[d]	Amount Handled per Day[e]	Daily Dermal Exposure[f] (mg/day)	Daily Inhalation Exposure[g] (mg/day)
Flagging Aerial Granular Applications (15)	0.0028	0.15	2 lb ai/acre	Ag	350 acres	2.0	0.11
			1 lb ai/acre			0.98	0.053

Footnotes:

a Baseline Dermal Unit Exposure values are taken from PHED (V1.1), and represent long pants, long sleeved shirt, no gloves, open mixing/loading, and open cab tractors, as appropriate. Open cockpit data are not available.

b Baseline Inhalation Unit Exposure values are taken from PHED (V1.1), and reflect no respiratory protection.

c Application rates come from values found on disulfoton labels (EPA Reg No. 3125-307, 2935-435, 3125-172, 34704-475).

d Crop Type or Target provides a general description of the intended uses of various products containing disulfoton. Separate categories are presented because of differences in application rates and acres treated.

e Amount Handled Per Day values are from default estimates of acreage treated, or number of pots handled in a single day for each exposure scenario of concern, based on the application method.

f Daily Dermal Exposure (mg/day) = Dermal Unit Exposure (mg/lb ai) * Application Rate (lb ai/acre) * Amount Handled Per Day (acres/day).

g Daily Inhalation Exposure (mg/day) = Inhalation Unit Exposure (μg/lb ai) * (1 mg/1000 μg) Conversion * Application Rate (lb ai/acre) * Amount Handled Per Day (acres/day).

h Application rates for trees are based on planting with 10-foot centers, which is equivalent to 435 trees/acre.

i Shrubs/trees application rate is calculated on an estimates of 2-inch trunk diameter when measured 4-feet from the ground. The plantings use a 10-foot center planting which corresponds to 435 trees/shrubs per acre.

j This application rate is for coffee trees estimated to be 8-feet in height, planted with 10-foot centers.

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Table 5. Occupational Handler Short-term and Intermediate-term Risks from Disulfoton at Baseline

Exposure Scenario (Scenario. #)	Crop Type or Target[a]	Application Rate (lb ai/acre)[b]	Amount Handled per Day[c]	Baseline Dermal			Baseline Inhalation		Baseline Total	
				Daily Dose (mg/kg/day)[d]	Short-term MOE[e]	Int.-term MOE[f]	Daily Dose (mg/kg/day)[g]	MOE[h]	Short-term MOE[i]	Int.-term MOE[j]
Mixer/Loader Risk										
Mixing/Loading Liquid Formulations (Emulsifiable Concentrates) for Aerial/ Chemigation Application (1a)	Ag (potatoes)	3 chemigation only	350 acres	44	0.009	0.002	0.018	2.5	0.009	0.002
	Ag (barley)	1		15	0.03	0.006	0.0060	7.5	0.03	0.006
	Ag (sorghum)	0.5		7.3	0.06	0.01	0.0030	15	0.06	0.01
Mixing/Loading Liquid Formulations (Emulsifiable Concentrates) for Ground-boom Application(1b)	Ag (potatoes)	4	80 acres	13	0.03	0.006	0.0055	8.2	0.03	0.006
	Ag (wheat)	1		3.3	0.1	0.03	0.0014	33	0.1	0.03
	Ag (sorghum)	0.5		1.7	0.2	0.05	0.00069	66	0.2	0.05
Mixing/Loading Liquid Formulations (Emulsifiable Concentrates) for Orchard Airblast Sprayer Application (1c)	Ag (pecans)	3	40 acres	5.0	0.08	0.02	0.0021	22	0.08	0.02
Loading Granulars for Aerial Application (2a)	Ag (cotton)	2	350 acres	0.084	4.8	1.0	0.017	2.7	1.7	0.7
	Ag (barley)	1		0.042	9.5	2.0	0.0085	5.3	3.4	1.4

Table 5. Occupational Handler Short-term and Intermediate-term Risks from Disulfoton at Baseline (Continued)

Exposure Scenario (Scenario. #)	Crop Type or Target[a]	Application Rate (lb ai/acre)[b]	Amount Handled per Day[c]	Baseline Dermal			Baseline Inhalation		Baseline Total	
				Daily Dose (mg/kg/day)[d]	Short-term MOE[e]	Int.-term MOE[f]	Daily Dose (mg/kg/day)[g]	MOE[h]	Short-term MOE[i]	Int.-term MOE[j]
Loading Granulars for Tractor-Drawn Spreader Application (2b)	Ag (raspberries)	8	80 acres	0.077	5.2	1.1	0.016	2.9	1.9	0.8
	Ag (potatoes)	4		0.038	10	2.2	0.0078	5.8	3.7	1.6
	Ag (cabbage)	1		0.0096	42	8.7	0.0019	23	15	6.3
	Nut Trees	3	2 acres	0.00072	560	120	0.00015	300	200	84
	Non-Bearing Fruit Trees	102		0.024	16	3.4	0.0050	9.1	5.8	2.5
	Flowers/ Groundcover	28.6		0.0069	58	12	0.0014	32	21	8.8
Applicator Risk										
Applying Sprays with a Fixed-Wing Aircraft (3)	Ag (barley)	1	350 acres	No Data See Eng. Cont.	No Data See Eng. Cont.	No Data See Eng. Cont.	No Data See Eng. Cont.	No Data See Eng. Cont.	No Data See Eng. Cont.	No Data See Eng. Cont.
	Ag (sorghum)	0.5								
Applying Granulars with a Fixed-Wing Aircraft (4)	Ag (cotton)	2	350 acres	No Data See Eng. Cont.	No Data See Eng. Cont.	No Data See Eng. Cont.	No Data See Eng. Cont.	No Data See Eng. Cont.	No Data See Eng. Cont.	No Data See Eng. Cont.
	Ag (barley)	1								
Applying Sprays with a Helicopter (5)	Ag (barley)	1	350 acres	No Data See Eng. Cont.	No Data See Eng. Cont.	No Data See Eng. Cont.	No Data See Eng. Cont.	No Data See Eng. Cont.	No Data See Eng. Cont.	No Data See Eng. Cont.
	Ag (sorghum)	0.5								
Applying Granulars with a Helicopter (6)	Ag	2	350 acres	No Data See Eng. Cont.	No Data See Eng. Cont.	No Data See Eng. Cont.	No Data See Eng. Cont.	No Data See Eng. Cont.	No Data See Eng. Cont.	No Data See Eng. Cont.
		1								

Table 5. Occupational Handler Short-term and Intermediate-term Risks from Disulfoton at Baseline (Continued)

Exposure Scenario (Scenario. #)	Crop Type or Target[a]	Application Rate (lb ai/acre)[b]	Amount Handled per Day[c]	Baseline Dermal			Baseline Inhalation		Baseline Total	
				Daily Dose (mg/kg/day)[d]	Short-term MOE[e]	Int.-term MOE[f]	Daily Dose (mg/kg/day)[g]	MOE[h]	Short-term MOE[i]	Int.-term MOE[j]
Applying Sprays with a Groundboom (7)	Ag (potatoes)	4	80 acres	0.064	6.3	1.3	0.0034	13	4.3	1.2
	Ag (wheat)	1		0.016	25	5.2	0.00085	53	17	4.7
	Ag (sorghum)	0.5		0.0080	50	10	0.00042	110	34	9.5
Applying Sprays to Orchards with an Airblast (8)	Ag	3	40 acres	0.62	0.6	0.1	0.0077	5.8	0.6	0.1
Applying Granulars with a Tractor-Drawn Spreader (9)	Ag (raspberries)	8	80 acres	0.091	4.4	0.9	0.011	4.1	2.1	0.8
	Ag (potatoes)	4		0.045	8.8	1.8	0.0055	8.2	4.3	1.5
	Ag (cabbage)	1		0.011	35	7.4	0.0014	33	17	6.0
	Nut Trees	3	2 acres	0.00085	470	98	0.00010	440	230	80
	Non-Bearing Fruit Trees	102		0.029	14	2.9	0.0035	13	6.7	2.4
	Flowers/ Groundcover	28.6		0.0081	49	10	0.00098	46	24	8.4
Mixer/Loader/Applicator Risk										
Loading/Applying Granulars Using a Belly Grinder (10)	Ag (strawberries)	4	2 acres	1.1	0.4	0.07	0.0071	6.4	0.3	0.07
	Ag (spinach)	1		0.29	1.4	0.3	0.0018	25	1.3	0.3
	Flowers/ Groundcover	28.6	2 acres	8.2	0.05	0.01	0.051	0.9	0.05	0.01

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Table 5. Occupational Handler Short-term and Intermediate-term Risks from Disulfoton at Baseline (Continued)

Exposure Scenario (Scenario. #)	Crop Type or Target[a]	Application Rate (lb ai/acre)[b]	Amount Handled per Day[c]	Baseline Dermal			Baseline Inhalation		Baseline Total	
				Daily Dose (mg/kg/day)[d]	Short-term MOE[e]	Int.-term MOE[f]	Daily Dose (mg/kg/day)[g]	MOE[h]	Short-term MOE[i]	Int.-term MOE[j]
Loading/Applying Granulars with a Push-Type Granular Spreader (11)	Nut Trees	3	2 acres	0.25	1.6	0.3	0.00054	83	1.6	0.3
	Non-Bearing Fruit Trees	102		8.5	0.05	0.01	0.018	2.5	0.05	0.01
	Shrubs/Trees (inc. Christmas Trees)	20		1.7	0.2	0.05	0.0036	13	0.2	0.05
		4.3		0.36	1.1	0.2	0.00077	58	1.1	0.2
	Ag (strawberries)	4	2 acres	0.33	1.2	0.3	0.00072	63	1.2	0.3
	Ag (spinach)	1		0.083	4.8	1.0	0.00018	250	4.7	1.0
	Flowers/ Groundcover	28.6	2 acres	2.4	0.2	0.04	0.0051	8.7	0.2	0.04
Loading/Applying Granulars by Hand, with a Spoon, Shaker Can, or a Measuring Scoop (12)[m]	Potted Plants	0.00052 lb ai/12 inch pot	350 pots	0.26	1.5	0.3	0.0012	37	1.5	0.3
Applying Ready-to-Use Liquid as a Seed Treatment (13)	Ag (Cotton)	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
Flagger Risk										
Flagging Aerial Spray Applications (14)	Ag (barley)	1	350 acres	0.055	7.3	1.5	0.0018	26	5.7	1.4
	Ag (sorghum)	0.5		0.028	15	3.0	0.00088	51	11	2.9
Flagging Aerial Granular Applications (15)	Ag (cotton)	2	350 acres	0.028	14	3.0	0.0015	30	9.7	2.7
	Ag (barley)	1		0.014	29	6.0	0.00075	60	19	5.4

Table 5. Occupational Handler Short-term and Intermediate-term Risks from Disulfoton at Baseline (Continued)

Footnotes:

a Crop Type or Target provides a general description of the intended uses of various products containing disulfoton. Separate categories are presented because of the distinct differences in application rates and acres treated.
b Application rates come from values found on disulfoton labels. (See footnotes for Table 4 for specifics).
c Amount Handled Per Day values are from default estimates of acreage treated, or number of pots handled in a single day for each exposure scenario of concern, based on the application method.
d Baseline Daily Dermal Dose (mg/kg/day) = Daily Dermal Exposure (mg/day) / Body Weight (70 kg).
e Baseline Dermal Short-term MOE = NOEL (0.4 mg/kg/day) / Baseline Daily Dermal Dose (mg/kg/day).
f Baseline Dermal Intermediate-term MOE = NOEL (0.03 mg/kg/day) / [Baseline Daily Dermal Dose (mg/kg/day) * 0.36 Dermal Absorption Factor].
g Baseline Daily Inhalation Dose (mg/kg/day) = Daily Inhalation Exposure (mg/day) / Body Weight (70 kg)).
h Inhalation MOE = NOEL (0.045 mg/kg/day) / Baseline Daily Inhalation Dose (mg/kg/day).
i Total Short-term MOE = 1/[(1/Short-term Dermal MOE) + (1/Inhalation MOE)].
j Total Intermediate-term MOE = 1/[(1/Intermediate-term Dermal MOE) + (1/Inhalation MOE)].

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Table 6. Occupational Handler Short-term and Intermediate-term Risks from Disulfoton with Additional PPE

Exposure Scenario (Scenario. #)	Crop Type or Target[a]	Application Rate (lb ai/acre)	Amount Handled per Day[b]	Dermal - Additional PPE[c]				Inhalation - Additional PPE[d]			Total - Additional PPE	
				Unit Exposure (mg/lb ai)	Daily Dose (mg/kg/day)[e]	Short-term MOE[f]	Int.-term MOE[g]	Unit Exposure (μg/lb ai)	Daily Dose (mg/kg/day)	MOE[h]	Short-term MOE[i]	Int.-term MOE[j]
Mixer/Loader Risk												
Mixing/Loading Liquid Formulations (Emulsifiable Concentrates) for Aerial/ Chemigation Application (1a)	Ag (potatoes)	chemigation only 3	350 acres	0.017	0.26	1.6	0.3	0.24	0.0036	13	1.4	0.3
	Ag (barley)	1			0.085	4.7	1.0		0.0012	38	4.2	1.0
	Ag (sorghum)	0.5			0.043	9.4	2.0		0.00060	75	8.4	1.9
Mixing/Loading Liquid Formulations (Emulsifiable Concentrates) for Ground-boom Application(1b)	Ag (potatoes)	4	80 acres	0.017	0.078	5.1	1.1	0.24	0.0011	41	4.6	1.0
	Ag (wheat)	1			0.019	21	4.3		0.00027	160	18	4.2
	Ag (sorghum)	0.5			0.0097	41	8.6		0.00014	330	37	8.4
Mixing/Loading Liquid Formulations (Emulsifiable Concentrates) for Orchard Airblast Sprayer Application (1c)	Ag (pecans)	3	40 acres	0.017	0.029	14	2.9	0.24	0.00041	110	12	2.8
Loading Granulars for Aerial Application (2a)	Ag (cotton)	2	350 acres	0.0034	0.034	12	2.5	0.34	0.0034	13	6.2	2.1
	Ag (barley)	1			0.017	24	4.9		0.0017	26	12	4.1
Loading Granulars for Tractor-Drawn Spreader Application (2b)	Ag (raspberries)	8	80 acres	0.0034	0.031	13	2.7	0.34	0.0031	14	6.9	2.3
	Ag (potatoes)	4			0.016	26	5.4		0.0016	29	14	4.5
	Ag (cabbage)	1			0.0039	100	21		0.00039	120	54	18
	Nut Trees	3	2 acres		0.00029	NA	290		0.000029	1,600	NA	240
	Non-Bearing Fruit Trees	102			0.0099	40	8.4		0.00099	45	21	7.1

Table 6. Occupational Handler Short-term and Intermediate-term Risks from Disulfoton with Additional PPE (Continued)

Exposure Scenario (Scenario. #)	Crop Type or Target[a]	Application Rate (lb ai/acre)	Amount Handled per Day[b]	Dermal - Additional PPE[c]				Inhalation - Additional PPE[d]			Total - Additional PPE	
				Unit Exposure (mg/lb ai)	Daily Dose (mg/kg/day)[e]	Short-term MOE[f]	Int.-term MOE[g]	Unit Exposure (µg/lb ai)	Daily Dose (mg/kg/day)	MOE[h]	Short-term MOE	Int.-term MOE[i]
	Flowers/ Groundcover	28.6			0.0028	140	30		0.00028	160	76	25
Applicator Risk												
Applying Sprays with a Fixed-Wing Aircraft (3)	Ag (barley)	1	350 acres	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.
	Ag (sorghum)	0.5										
Applying Granulars with a Fixed-Wing Aircraft (4)	Ag (cotton)	2	350 acres	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.
	Ag (barley)	1										
Applying Sprays with a Helicopter (5)	Ag (barley)	1	350 acres	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.
	Ag (sorghum)	0.5										
Applying Granulars with a Helicopter (6)	Ag	2	350 acres	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.	No Data See Eng. Con.
		1										
Applying Sprays with a Groundboom (7)	Ag (potatoes)	4	80 acres	0.011	0.05	8.0	1.7	0.15	0.00069	66	7.1	1.6
	Ag (wheat)	1			0.013	32	6.6		0.00017	260	28	6.5
	Ag (sorghum)	0.5			0.0063	64	13		0.000086	530	57	13
Applying Sprays to Orchards with an Airblast (8)	Ag	3.0	40 acres	0.22	0.38	1.1	0.2	0.90	0.0015	29	1.0	0.2

Table 6. Occupational Handler Short-term and Intermediate-term Risks from Disulfoton with Additional PPE (Continued)

Exposure Scenario (Scenario. #)	Crop Type or Target[a]	Application Rate (lb ai/acre)	Amount Handled per Day[b]	Dermal - Additional PPE[c]				Inhalation - Additional PPE[d]			Total - Additional PPE	
				Unit Exposure (mg/lb ai)	Daily Dose (mg/kg/day)[e]	Short-term MOE[f]	Int.-term MOE[g]	Unit Exposure (µg/lb ai)	Daily Dose (mg/kg/day)	MOE[h]	Short-term MOE[i]	Int.-term MOE[k]
Applying Granulars with a Tractor-Drawn Spreader (9)	Ag (raspberries)	8	80 acres	0.0042	0.038	10	2.2	0.24	0.0022	21	6.9	2.0
	Ag (potatoes)	4			0.019	21	4.3		0.0011	41	14	3.9
	Ag (cabbage)	1			0.0048	83	17		0.00027	160	55	16
	Nut Trees	3	2 acres	0.0042	0.00036	NA	230	0.24	0.000021	2,200	NA	210
	Non-Bearing Fruit Trees	102			0.012	33	6.8		0.00070	64	22	6.2
	Flowers/ Groundcover	28.6			0.0034	120	24		0.00020	230	77	22
Mixer/Loader/Applicator Risk												
Loading/Applying Granulars Using a Belly Grinder (10)	Ag (strawberries)	4	2 acres	17	1.9	0.2	0.04	12	0.0014	33	0.2	0.04
	Ag (spinach)	1			0.49	0.8	0.2		0.00034	130	0.8	0.2
	Flowers/ Groundcover	28.6	2 acres		14	0.03	0.006		0.0098	4.6	0.03	0.006

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Table 6. Occupational Handler Short-term and Intermediate-term Risks from Disulfoton with Additional PPE (Continued)

Exposure Scenario (Scenario. #)	Crop Type or Target[a]	Application Rate (lb ai/acre)	Amount Handled per Day[b]	Dermal - Additional PPE[c]				Inhalation - Additional PPE[d]			Total - Additional PPE	
				Unit Exposure (mg/lb ai)	Daily Dose (mg/kg/day)[e]	Short-term MOE[f]	Int.-term MOE[g]	Unit Exposure (µg/lb ai)	Daily Dose (mg/kg/day)	MOE[h]	Short-term MOE[i]	Int.-term MOE[k]
Loading/Applying Granulars with a Push-Type Granular Spreader (11)	Nut Trees	3	2 acres	0.73	0.063	6.4	1.3	1.3	0.00011	400	6.3	1.3
	Non-Bearing Fruit Trees	102			2.1	0.2	0.04		0.0038	12	0.2	0.04
	Shrubs/Trees (inc. Christmas Trees)	20			0.42	1.0	0.2		0.00074	61	0.9	0.2
		4.3			0.090	4.5	0.9		0.00016	280	4.4	0.9
	Ag (strawberries)	4	2 acres		0.083	4.8	1.0		0.00015	300	4.7	1.0
	Ag (spinach)	1			0.021	19	4.0		0.000037	1,200	19	4.0
	Flowers/ Groundcover	28.6	2 acres		0.60	0.7	0.1		0.0011	42	0.7	0.1
Loading/Applying Granulars by Hand, with a Spoon, Shaker Can, or a Measuring Scoop (12)	Potted Plants	0.00052 lb ai/12 inch pot	350 pots	40[j]	0.10	3.8	0.8	47 ov resp[l,m]	0.00012	370	3.8	0.8
								94 dm mask[l,m]	0.00024	180	3.8	0.8
Applying Ready-to-Use Liquid as a Seed Treatment (13)	Ag (cotton)	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
Flagger Risk												
Flagging Aerial Spray Applications (14)	Ag (barley)	1	350 acres	0.010	0.050	8	1.7	0.070	0.00035	130	7.5	1.6
	Ag (sorghum)	0.5			0.025	16	3.3		0.00018	260	15	3.3
Flagging Aerial Granular Applications (15)	Ag (cotton)	2	350 acres	0.0016	0.016	25	5.2	0.030	0.00030	150	21	5.0
	Ag (barley)	1			0.0080	50	10		0.00015	300	43	10

Table 6. Occupational Handler Short-term and Intermediate-term Risks from Disulfoton with Additional PPE (Continued)

Footnotes:

a. Crop Type or Target provides a general description of the intended uses of various products containing disulfoton. Separate categories are presented because of the distinct differences in application rates and acres treated.
b. Amount Handled Per Day values are from default estimates of acreage treated, or number of pots handled in a single day for each exposure scenario of concern, based on the application method
c. Additional PPE for all scenarios includes double layer of clothing (50% PF for clothing, except scenario 2, for which double layer data were available), and chemical resistant gloves. Flagger exposure values (scenarios 14 and 15 are based on double layer of clothing and no gloves).
d. Additional PPE represents dust/mist respirator (5-fold PF), except for indoor application of scenario 12, which labels state use an OV respirator (10-fold PF). See footnote m below.
e. Daily Dermal Dose (mg/kg/day) = Daily Dermal Exposure (mg/day)/ Body weight (70 kg).
f. Short-term Dermal MOE = NOEL (0.4 mg/kg/day)/ Daily Dermal Dose (mg/kg/day).
g. Intermediate-term Dermal MOE = NOEL (0.03 mg/kg/day)/Absorbed Daily Dermal Dose (mg/kg/day). Absorbed Dermal Dose = Daily Dermal Dose * 0.36 Dermal Absorption Factor.
h. Daily Inhalation Dose (mg/kg/day) = Daily Inhalation Exposure (mg/day)/ Body weight (70 kg).
i. Inhalation MOE = NOEL (0.045 mg/kg/day)/ Daily Inhalation Dose (mg/kg/day).
j. Total Short-term MOE = 1/ [(1/ Short-term Dermal MOE) + (1/ Inhalation MOE)].
k. Total Intermediate-term MOE = 1/ ((1/ Intermediate-term Dermal MOE) + (1/Inhalation MOE)).
l. Unit exposure data for application of granules by hand were used as surrogate values for these scenarios.
m. Disulfoton labels require use of an OV respirator (10-Fold PF) for indoor applications, and use of dust mist respirator for outdoor applications.

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Table 7. Occupational Handler Short-term and Intermediate-term Risks from Disulfoton with Engineering Controls

Exposure Scenario (Scenario. #)	Crop Type or Target[a]	Application Rate (lb ai/acre)[b]	Amount Handled per Day[c]	Dermal - Engineering Controls[d]				Inhalation - Engineering Controls[d]			Total - Engineering Controls	
				Unit Exposure (mg/lb ai)[e]	Daily Dose (mg/kg/day)[f]	Short-term MOE[g]	Int.-term MOE[h]	Unit Exposure (μg/lb ai)[e]	Daily Dose (mg/kg/day)	MOE[i]	Short-term MOE[j]	Int.-term MOE[k]
Mixer/Loader Risk												
Mixing/Loading Liquid Formulations (Emulsifiable Concentrates) for Aerial/ Chemigation Application (1a)	Ag (potatoes)	chemigation only 3	350 acres	0.0086	0.13	3.1	0.6	0.083	0.0012	36	2.9	0.6
	Ag (barley)	1			0.043	9.3	1.9		0.00042	110	8.6	1.9
	Ag (sorghum)	0.5			0.022	19	3.9		0.00021	220	17	3.8
Mixing/Loading Liquid Formulations (Emulsifiable Concentrates) for Ground-boom Application(1b)	Ag (potatoes)	4	80 acres	0.0086	0.039	10	2.1	0.083	0.00038	120	9.4	2.1
	Ag (wheat)	1			0.0098	41	8.5		0.000095	470	37	8.3
	Ag (sorghum)	0.5			0.0049	81	17		0.000047	950	75	17
Mixing/Loading Liquid Formulations (Emulsifiable Concentrates) for Orchard Airblast Sprayer Application (1c)	Ag (pecans)	3	40 acres	0.0086	0.015	27	5.7	0.083	0.00014	320	25	5.6
Loading Granulars for Aerial Application (2a)	Ag (cotton)	2	350 acres	0.00017	0.0017	240	49	0.034	0.00034	130	85	36
	Ag (barley)	1			0.00085	470	98		0.00017	260	170	72

Table 7. Occupational Handler Short-term and Intermediate-term Risks from Disulfoton with Engineering Controls (Continued)

Exposure Scenario (Scenario. #)	Crop Type or Target[a]	Application Rate (lb ai/acre)[b]	Amount Handled per Day[c]	Dermal - Engineering Controls[d]				Inhalation - Engineering Controls[d]			Total - Engineering Controls	
				Unit Exposure (mg/lb ai)[e]	Daily Dose (mg/kg/day)[f]	Short-term MOE[g]	Int.-term MOE[h]	Unit Exposure (µg/lb ai)[e]	Daily Dose (mg/kg/day)	MOE[i]	Short-term MOE[j]	Int.-term MOE[k]
Loading Granulars for Tractor-Drawn Spreader Application (2b) (H)	Ag (raspberries)	8	80 acres	0.00017	0.0016	260	54	0.034	0.00031	140	93	39
	Ag (potatoes)	4			0.00078	510	110		0.00016	290	190	78
	Ag (cabbage)	1			0.00019	2,100	430		0.000039	1,200	740	310
	Nut Trees	3	2 acres		NA	NA	NA		NA	NA	NA	NA
	Non-Bearing Fruit Trees	102			0.00050	810	170		0.000099	450	290	120
	Flowers/ Groundcover	28.6			0.00014	2,900	600		0.000028	1,600	1,000	440
Applicator Risk												
Applying Sprays with a Fixed-Wing Aircraft (3)	Ag (barley)	1	350 acres	0.0050	0.025	16	3.3	0.068	0.00034	130	14	3.3
	Ag (sorghum)	0.5			0.013	32	6.7		0.00017	260	29	6.5
Applying Granulars with a Fixed-Wing Aircraft (4)	Ag (cotton)	2	350 acres	0.0017	0.017	24	4.9	1.3	0.013	3.5	3.0	2.0
	Ag (barley)	1			0.0085	47	9.8		0.0065	6.9	6.0	4.1
Applying Sprays with a Helicopter (5)	Ag (barley)	1	350 acres	0.0019	0.0095	42	8.8	0.0018	0.0000090	5,000	42	8.8
	Ag (sorghum)	0.5			0.0048	84	18		0.0000045	10,000	84	18
Applying Granulars with a Helicopter (6)	Ag	2	350 acres		No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
		1										
Applying Sprays with a Groundboom (7) (H)	Ag (potatoes)	4	80 acres	0.0050	0.023	18	3.6	0.043	0.00020	230	16	3.6
	Ag (wheat)	1			0.0057	70	15		0.000049	920	65	14
	Ag (sorghum)	0.5			0.0029	140	29		0.000025	1,800	130	29

Table 7. Occupational Handler Short-term and Intermediate-term Risks from Disulfoton with Engineering Controls (Continued)

Exposure Scenario (Scenario. #)	Crop Type or Target[a]	Application Rate (lb ai/acre)[b]	Amount Handled per Day[c]	Dermal - Engineering Controls[d]				Inhalation - Engineering Controls[d]			Total - Engineering Controls	
				Unit Exposure (mg/lb ai)[e]	Daily Dose (mg/kg/day)[f]	Short-term MOE[g]	Int.-term MOE[h]	Unit Exposure (µg/lb ai)[e]	Daily Dose (mg/kg/day)	MOE[i]	Short-term MOE[j]	Int.-term MOE[k]
Applying Sprays to Orchards with an Airblast (8)	Ag	3	40 acres	0.14	0.24	1.7	0.3	0.45	0.00077	58	1.6	0.4
Applying Granulars with a Tractor-Drawn Spreader (9)	Ag (raspberries)	8	80 acres	0.0021	0.019	21	4.3	0.22	0.0020	22	11	3.6
	Ag (potatoes)	4			0.0096	42	8.7		0.0010	45	22	7.3
	Ag (cabbage)	1			0.0024	170	35		0.00025	180	86	29
	Nut Trees	3	2 acres		NA	NA	NA		NA	NA	NA	NA
	Non-Bearing Fruit Trees	102			0.0061	65	14		0.00064	70	33	11
	Flowers/ Groundcover	28.6			0.0017	230	49		0.00018	250	120	41
Mixer/Loader/Applicator Risk												
Loading/Applying Granulars Using a Belly Grinder (10)	Ag (strawberries)	4	2 acres	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Ag (spinach)	1										
	Flowers/ Groundcover	28.6	2 acres	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 7. Occupational Handler Short-term and Intermediate-term Risks from Disulfoton with Engineering Controls (Continued)

Exposure Scenario (Scenario. #)	Crop Type or Target[a]	Application Rate (lb ai/acre)[b]	Amount Handled per Day[c]	Dermal - Engineering Controls[d]				Inhalation - Engineering Controls[d]			Total - Engineering Controls	
				Unit Exposure (mg/lb ai)[e]	Daily Dose (mg/kg/day)[f]	Short-term MOE[g]	Int.-term MOE[h]	Unit Exposure (µg/lb ai)[e]	Daily Dose (mg/kg/day)	MOE[i]	Short-term MOE[j]	Int.-term MOE[k]
Loading/Applying Granulars with a Push-Type Granular Spreader (11)	Nut Trees	3	2 acres	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Non-Bearing Fruit Trees	102		NA	NA	NA	NA	NA	NA	NA	NA	NA
	Shrubs/Trees (inc. Christmas Trees)	20		NA	NA	NA	NA	NA	NA	NA	NA	NA
		4.3										
	Ag (strawberries)	4	2 acres	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Ag (spinach)	1										
	Flowers/ Groundcover	28.6	2 acres	NA	NA	NA	NA	NA	NA	NA	NA	NA
Loading/Applying Granulars by Hand, with a Spoon, Shaker Can, or a Measuring Scoop (12)[m]	Potted Plants	0.00052 lb ai/12 inch pot	350 pots	NA	NA	NA	NA	NA	NA	NA	NA	NA
Applying Ready-to-Use Liquid as a Seed Treatment (13)	Ag (Cotton)	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
Flagger Risk												
Flagging Aerial Spray Applications (14)	Ag (barley)	1	350 acres	0.0050[l]	0.025	16	3.3	0.043	0.00022	210	15	3.3
	Ag (sorghum)	0.5			0.013	32	6.7		0.00011	420	30	6.6
Flagging Aerial Granular Applications (15)	Ag (cotton)	2	350 acres	0.0021[m]	0.021	19	4.0	0.22	0.0022	20	9.9	3.3
	Ag (barley)	1			0.011	38	7.9		0.0011	41	20	6.6

otnotes:

\ =Not Applicable

Crop Type or Target provides a general description of the intended uses of various products containing disulfoton. Separate categories are presented because of differences in application rates and acres treated.
Application rate taken from disulfoton labels.
Amount Handled Per Day values are from default estimates of acreage treated, or number of pots handled in a single day for each exposure scenario of concern, based on the application method.
Engineering Controls are: closed mixing and loading , single layer of clothing, and chemical resistant gloves (1a, b, c); Closed loading of granulars (2a, b); single layer of clothing, no gloves and enclosed cockpit or cab (3,4,5,6,7, 14, and 15)
Unit Exposure Values = From PHED V1.1 dated May 1997.
Daily Dose (mg/kg/day) = Daily Inhalation Exposure (mg/day)/ Body weight (70 kg).
Short-term Dermal MOE = LOEL (0.4 mg/kg/day)/ Daily Dermal Dose (mg/kg/day).
Intermediate-term Dermal MOE = NOEL (0.03 mg/kg/day)/ Absorbed Daily Dermal Dose (mg/kg/day), which is Daily Dermal Dose * 0.36 (dermal absorption factor).
Inhalation MOE = NOEL (0.045 mg/kg/day) / Daily Inhalation Dose.
Total Short-term MOE = 1/ ((1/ Dermal MOE) + (1/ .Inhalation MOE)).
Total Intermediate-term MOE = 1/ ((1/ Dermal MOE) + (1/ Inhalation MOE)).
Based on data for groundboom, enclosed cab.
Based on data for granular drop type tractor-drawn spreader, enclosed cab.

Handler Exposure and Risk Estimates for Cancer

Summary of Risk Concerns for Handlers, Data Gaps, and Confidence in Exposure and Risk Estimates

Handler Scenarios with Risk Concerns

The calculations of short-term risks indicate that **total short-term MOEs** are greater than 100 at **baseline** for **none** of the assessed exposure scenarios **except** the following:

- (2b) loading granulars with a tractor-drawn spreader to nut (pecan) trees assuming an application rate of 3 lb ai/acre, applied to 2 acres per day.

- (9) applying granulars with a tractor-drawn spreader to nut (pecan) trees assuming an application rate of 3 lb ai/acre, applied to 2 acres per day.

The calculations of intermediate-term risks indicate that **total intermediate-term MOEs** are greater than 100 at **baseline** for **none** of the assessed exposure scenarios.

The calculations of short-term risks indicate that **total short-term MOEs** are greater than 100 at **with additional PPE** for **no** additional scenarios other than those mentioned above.

The calculations of short-term and intermediate-term risks indicate that **total intermediate -term MOEs** are more than 100 at **with additional PPE** for **none** of the assessed exposure scenarios **except** the following:

- (2a) loading granulars with a tractor-drawn spreader to nut (pecan) trees assuming an application rate of 3 lb ai/acre, applied to 2 acres per day.

- (9) applying granulars with a tractor-drawn spreader to nut (pecan) trees assuming an application rate of 3 lb ai/acre, applied to 2 acres per day.

The calculations of **total short-term risks** indicate that MOEs are more than 100 with **additional PPE** (Table 6) for the following additional scenarios:

- (2a) loading granulars for aerial application using a 1.0 lb ai/acre application rate.

- (2b) loading granulars for tractor-drawn spreader application to agricultural crops at application rates of 1 lb ai/acre and 4 lb ai/acre. MOEs are greater than 100 also for loading of granulars for application to non-bearing fruit trees and to flowers and groundcovers using a tractor-drawn spreader.

- (7) applying with a groundboom to agricultural crops using an application rate of 0.5 lb ai/acre.

- (9) applying granulars with a tractor-drawn spreader to flowers and groundcover using an application rate of 28.6 lb ai/acre.

The calculations of **total intermediate-term risks** indicate that MOEs are more than **100** with **additional PPE** (Table 6) for the following:

- (2b) loading granulars for tractor-drawn spreader application to agricultural crops at application rate of 1 lb ai/acre. MOEs are greater than 100 also for loading of granulars for application to non-bearing fruit trees and to flowers and groundcovers using a tractor-drawn spreader.

Data Gaps

As noted below in the data gaps discussion, several of the exposure scenarios could not be assessed due to lack of PHED surrogate data.

Data Gaps

Data gaps exist for the following scenario:

- (6) - no PHED data exist for applying granulars from helicopters.

- (16) - no PHED data exist for applying ready-to-use liquid as a seed treatment.

Data Quality and Confidence in Assessment

Several issues must be considered when interpreting the occupational exposure risk assessment. These include:

- Several handler assessments were completed using "low quality" PHED data due to the lack of a more acceptable dataset.

- Several generic protection factors were used to calculate handler exposures. These protection factors have not been completely evaluated and accepted by HED.

- Factors used to calculate daily exposures to handlers (e.g., acres treated per day and gallons of liquid applied) are based on the best professional judgement, due to a lack of pertinent data.

Chemical Studies Submitted in Support of Reregistration

MRID 422294-01

In support of the reregistration of disulfoton, Miles Inc. has submitted a study estimating handler exposures. The results were based on surrogate data derived from handler exposure studies of Terbufos, Baythroid, and Bayleton which are referenced in Table 8. Surrogate exposure estimates for foliar applications to agricultural crops were based on a study of exposure to triadimefon during ground spray applications to wheat. Exposure estimates for soil-applied granular application of disulfoton were based on a published study of exposures to terbufos during planting of corn. Surrogate exposure estimates for aerial applications of disulfoton to agricultural crops were based on a study of exposure to cyfluthrin during aerial application of Baythroid 2 insecticide to cotton.

Data from this study were not considered in estimating occupational handler doses and risks in this assessment. The application rates used in MRID 422294-01 are within the range of rates used in this assessment. The acreage treated per day values used in the Miles study are greater than default estimates typically used by EPA. A dermal NOEL of 0.4 mg/kg/day, and an inhalation NOEL of 0.045 mg/kg/day were used in this assessment, while a dermal NOEL of 0.8 mg/kg/day, and an inhalation NOEL of 0.069 mg/kg/day were used in the Miles study. The MOEs observed by the registrant (as shown in Table 8) were somewhat higher than those calculated in this assessment.

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Table 8. MRID 422294-01 Results: Summary of Di-Syston® Exposure Estimates[a]

Worker Exposure Activity	Application Rate[b] (lb ai/acre)	Amount Handled per Day[c] (acres)	Dermal Exposure (Dose)[d] (μg/kg/day)	Inhalation Exposure (Dose)[d] (μg/kg/day)	Dermal Margin of Safety (MOE)[e]	Inhalation Margin of Safety[f]
Mixer/Loader/Applicator (in furrow planting)	0.625 (cotton)	100	6.3	1.25	127	56
	3.0 (potatoes)		30.0	6.0	27	12
Mixer/Loader (ground-rig boom)	0.625 (cotton)	100	67.5	0.38	12	184
	3.0 (potatoes)		135.0	0.75	6	93
Mixer/Loader (aerial)	0.5 (cereals & corn)	900	<103.5	<0.90	8	78
	1.0		207.0	1.8	>4	>39
Applicator (ground-rig boom)	0.625 (cotton)	100	73.7	0.38	11	184
	3.0 (potatoes)		147.5	0.75	5	93
Mixer/Loader/Applicator (ground-rig boom)	0.625 (cotton)	100	84.8	0.90	9	155
	3.0 (potatoes)		169.5	0.45	5	78
Applicator (aerial)	0.5 (cereals & corn)	900	<135.0	<0.90	6	78
	1.0		270.0	1.8	>3	>39
Flagger (aerial)	0.5 (cereals & corn)	900	<99.0	<0.90	8	78
	1.0		198.0	1.8	>4	>39

Table 8. MRID 422294-01 Results: Summary of Di-syston® Exposure Estimates (continued)

Exposure estimates are presented in MRID #422294-01, and are based on the following studies:

1. Knarr, R.D. Applicator and Mixer/Loader Exposures to Triadimefon During Ground Spray Application of BAYLETON® 50 FD Fungicide to Wheat Fields. *Mills Inc. Report No. 96798.* (June 1988). *EPA MRID No. 40995921.*

2. Eberhart, D.C. Field Exposure Study: Aerial Applications of BAYTHROID® 2 on Cotton. *Miles Inc. Report No. 91768.* (March 1986). *EPA ACCESSION No. 263763.*

3. Devine, J.M.; Kinoshita, G.B.; Peterson, R.B.; Picard, G.L. Farm Worker Exposure to Terbufos [phosphorodithioc acid, s-(tert-budylthio) methyl O,O-diethyl ester] During Planting Operations of Corn. *Archives of Environmental Toxicology.* 15:113-119 (1986).

[b] Based on data from Miles, Inc. field research and marketing personnel.

[c] Based on data from Miles, Inc. field research and marketing personnel.

[d] The inhalation and dermal exposures in this study were calculated by assigning all non-detectable values a value equal to the analytical limit of detection.

[e] Based on a NOEL of 800 μg/kg/day. *Miles, Inc. Report #98347.*

[f] Based on a NOEL of 69 μg/kg/day. *Miles, Inc. Report #99648.*

Post-Application Exposures and Risks

Postapplication Exposure Scenarios, Data, and Assumptions:

Occupational Postapplication Exposure Scenarios and Assumptions

HED has determined that there are potential postapplication occupational exposures to individuals entering treated areas for the purpose of harvesting of nut trees (pecans); harvesting of low-growing field crops; weeding and scouting and other non-harvesting activities associated with low-growing field crops; and transplanting; harvesting, and pruning of ornamentals.

Based on these activities, four representative scenarios were evaluated using surrogate dislodgeable foliar residue data and assumptions about transfer of residues to the skin. The surrogate assessments presented in Tables 8 and 9 are based on the application rates recommended for field crops, nut trees and ornamentals on disulfoton labels, and assumptions regarding activity levels. These assumptions would be expected to bracket the reentry exposure levels anticipated from disulfoton use on these crop types. The four scenarios and assumptions addressed by the calculations are described below:

- Harvesting of nut trees (i.e., pecans);
- Harvesting activities of low growing field crops (e.g., peanuts, cotton, broccoli, cabbage);
- Non-harvesting reentry activity (scouting, hoeing, weeding) associated with applications to low growing field crops (e.g., peanuts, cotton);
- Pruning, transplanting, and bundling of flowers associated with applications to flowers, and ornamental shrub and trees.

Data Source Descriptions for Scenarios Considered

Chemical -specific postapplication exposure data have been submitted in support of the reregistration of disulfoton, however HED has found these studies to be unacceptable[5]. In lieu of these data, a surrogate rangefinder postapplication exposure assessment was conducted to determine potential occupational and residential postapplication risks from disulfoton. The intermediate term dermal toxicity value of 0.03 mg/kg/day was used to assess risks from disulfoton. A short-term dermal toxicity value of 0.4 mg/kg/day is also available for disulfoton. However, risks were evaluated for intermediate-term exposures as a conservative approach.

Chemical Studies (Postapplication)

MRID 405041-05 and MRID 404690-01

A reentry interval study was conducted to support the reregistration of disulfoton. The study evaluated dislodgeable residues of disulfoton on cotton and potatoes, and calculated reentry intervals (MRID 404690-01, and MRID 405041-05). Note that MRID 405041-05 is the same as study submission MRID 404690-0, except that MRID 404690-0 has an attached research and development phone report from Mobay Chemical Corporation summarizing a meeting between EPA personnel and Mobay personnel on the subject of reentry protocols and dislodgeable residues. The disulfoton study was conducted as a subset of MRID 404681-01 - Reentry Intervals for Azinphos-methyl, Oxydemeton-methyl, Disulfoton, and Anilazine. MRID 404681-01 was reviewed by HED and found to be unacceptable under Subdivision K Pesticide Assessment Guidelines. The study contained the following deficiencies:[5]

- QA/QC data were inadequate in regard to field recovery, laboratory recovery (with the exception of lab recovery data for soil residues), and storage stability;
- Analytic methods used for analysis of leaf wash and soil samples were not specified;
- Chromatograms were not included in the final report;
- Testing methodology was not clearly documented (i.e., application methods, plot sizes, site descriptions, leaf-punch diameter, soil characteristics, and soil extraction method);
- Lack of meteorological data and irrigation supplied at each site during the time frame of the study;
- Several discrepancies between study design and label requirements, including application rates, maximum number of applications, and intervals between applications for the representative crop groupings and the analyzed crop.

For these reasons, the data from this study were not used to calculate postapplication reentry risks. A surrogate scenario strategy was used instead.

Assumptions Used in Postapplication Exposure Calculations (Non-Cancer Risks)

The assumptions used in the calculations for occupational postapplication risks include the following items:

- Application rates used for the calculations:
  - Harvesting of nut trees - 3.0 lb ai/acre;

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-- Harvesting of low growing field crops - 8.0 lb ai/acre and 4.0 lb ai/acre;
-- Non-harvesting activities such as weeding and scouting - 8.0 lb ai/acre and 4.0 lb ai/acre; and
-- Pruning, and transplanting of ornamental shrubs and trees - 20 lb ai/acre and 4.3 lb ai/acre.

- Transfer coefficients (Tc) are assumed to be 10,000 cm^2/hour for the harvesting of nut trees; 3,500 cm^2/hour for harvesting activities of low growing field crops; 1,500 cm^2/hour for activities such as weeding and scouting of low growing vegetables; and 7,000 cm^2/hour for high contact activities in ornamental tree and shrub nurseries such as transplanting, pruning and bundling of flowers, shrubs and trees;.

- Exposure durations assumed to be 8 hours per day.

- Dermal absorption is assumed to be 36 percent, as in the intermediate-term handler assessment.

Postapplication Exposure and Non-Cancer Risk Estimates

The intermediate-term dermal risks from disulfoton has been assessed using surrogate regression data. The DFR is derived from the application rate assuming an estimated 10 percent of the rate applied is available as initial dislodgeable residues, and an estimated 25 percent dissipates per day. These assumptions have been made taking into consideration a 2-day half-life for disulfoton and the use of soil incorporation application methods. The equations used for the calculations are presented below.

Dislodgeable foliar residues (DFRs) were calculated as follows:

$$DFR\left(\frac{\mu g}{cm^2}\right) = AR\left(\frac{lb\ ai}{A}\right) \times CF\left(\frac{\mu g/cm^2}{lb\ ai/A}\right) \times F \times (1 - DR)^t$$

Where:

AR	=	Application rate
CF	=	Conversion factor (11.2 ug per cm^2 per lb ai per acre)
F	=	Fraction retained on foliage (10 percent)
DO	=	Daily dissipation rate (25 percent per day)
t	=	Days after treatment

Daily Absorbed Dermal Doses were calculated as follows:

$$Dose\ (mg/kg/d) = \frac{(DFR\ (\mu g/cm^2) \times Tc\ (cm^2/hr) \times CF \left(\frac{1\ mg}{1{,}000\ \mu g}\right) \times Abs \times ED\ (hrs/day))}{BW\ (kg)}$$

Where:

DFR = Dislodgeable foliar residue ($\mu g/cm^2$),
Tc = Transfer coefficient; 1,500 cm^2/hr for weeding, scouting of field and vegetable crops vegetables, 3,500 cm^2/hr for harvesting of low growing field crops, 7,000 cm^2/hr for the transplanting, pruning, repotting, and bundling of ornamental shrubs, trees, and flowers, and 10,000 cm^2/hr for harvesting nut trees
CF = Conversion factor (i.e., 1 mg/1,000 μg)
Abs = Dermal absorption (assume 36 percent)
ED = Exposure duration; 8 hours worked per day
BW = body weight (70 kg)

MOEs were calculated as follows:

$$MOE = \frac{NOEL\ (mg/kg/day)}{Dose\ (mg/kg/day)}$$

Where:

NOEL = 0.03 mg/kg/day
Dose = calculated absorbed dermal dose

Summary of Postapplication Risks

The acceptable MOE was assumed to be 100 for disulfoton. The resulting surrogate occupational postapplication assessments as shown in Table 9 and Table 10 indicate that:

- Disulfoton MOEs equal or exceed 100 for non-harvesting activities associated with agricultural crops (with a dermal transfer of 1,500 cm^2/hour) at the 27th day following applications at a rate of 8.0 pounds active ingredient per acre, and on the 24th day following applications at a rate of 4.0 pounds active ingredient per acre.

- Disulfoton MOEs equal or exceed 100 for harvesting activities associated with low growing field crops (with a dermal transfer of 3,500 cm^2/hour) at the 30th day following applications at a rate of 8.0 pounds active ingredient per acre, and on the 24th day following applications at a rate of 4.0 pounds active ingredient per acre.

- Disulfoton MOEs equal or exceed 100 for pruning and transplanting activities associated with ornamental shrubs, trees and flowers (with a dermal transfer of 7,000 cm^2/hour) at the 35th day following applications at a rate of 20 pounds active ingredient per acre, and on the 30th day following applications at a rate of 4.3 lb ai/acre.

- Disulfoton MOEs equal or exceed 100 for harvesting activities of nut (i.e., pecan) trees (with a dermal transfer of 10,000 cm^2/hour) at the 30th day following applications at a rate of 3.0 lb ai/acre.

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Table 9. Disulfoton Intermediate-Term Surrogate Occupational Postapplication Assessment (Range Finder) for Harvesting Nut Trees and Pruning Ornamentals

Harvesting of Nut Trees - applied at 3.0 lb ai/acre				Pruning Ornamentals - applied at 20.0 lb ai/acre				Pruning Ornamentals - applied at 4.3 lb ai/acre			
DAT[a]	DFR ($\mu g/cm^2$)[b]	Dermal Dose mg/kg/day	MOE	DAT[a]	DFR ($\mu g/cm^2$)[b]	Dermal Dose mg/kg/day	MOE	DAT	DFR ($\mu g/cm^2$)[b]	Dermal Dose mg/kg/day	MOE
0	3.4	1.4	0.02	0	22	6.5	0.005	0	4.8	1.4	0.02
27	0.0014	5.9E-4	51	33	0.0017	4.9E-4	62	27	0.0020	5.9E-4	51
30	0.00060	2.5E-4	120	35	0.00095	2.7E-4	110	30	0.00086	2.5E-4	120

Table 10. Disulfoton Intermediate-Term Surrogate Occupational Postapplication Assessment (Range Finder) for Low Growing Field Crops

Low Growing Field Crops - applied at 8.0 lb ai/acre						Low Growing Field Crops - applied at 4.0 lb ai/acre					
DAT[a]	DFR ($\mu g/cm^2$)[b]	Harvesting		Non-harvesting		DAT[a]	DFR ($\mu g/cm^2$)[b]	Harvesting		Non-harvesting	
		Dermal Dose mg/kg/day	MOE	Dermal Dose mg/kg/day	MOE			Dermal Dose mg/kg/day	MOE	Dermal Dose mg/kg/day	MOE
0	9.0	1.3	0.02	0.55	0.05	0	4.5	0.65	0.05	0.28	0.1
24	0.0090	1.3E-3	23	5.6E-4	54	22	0.0080	0.0011	26	0.00049	61
27	0.0038	5.5E04	55	2.3E-4	130	24	0.0045	6.5E-4	46	0.00028	110
30	0.0016	2.3E-4	130	NA	NA	27	0.0019	2.7E-4	110	NA	NA

a DAT is "days after treatment."
b Initial DFR = Application rate x Conversion factor (lb ai/acre = 11.209 $\mu g/cm^2$) x fraction of initial ai retained on foliage.

Residential and Other Non-Occupational Exposures and Risks

HED has determined that residential and other non-occupational handlers are likely to be exposed during disulfoton use. The anticipated use patterns and current labeling indicate several major exposure scenarios based on the types of equipment that potentially can be used to make disulfoton applications. These scenarios include: (1) loading/applying granulars with a belly grinder; (2) loading/applying with a push type granular spreader; (3) loading/applying granulars with a spoon, shaker can, measuring scoop, or by hand; (4) application of insecticidal spikes.

Residential Handler Exposure Scenarios-Data and Assumptions

Residential handler exposure assessments were completed by HED using a baseline exposure scenario. PHED values used to estimate daily unit exposure values were taken from the *Standard Operating Procedures (SOPs) for Residential Exposure Assessments* document dated December 1997.[5] Table 11 summarizes the caveats and parameters specific to the surrogate data used for each scenario and corresponding exposure/risk assessment. The following assumptions and factors were used in order to complete this exposure assessment:

- Calculations are completed at the maximum application rates for specific crops recommended by the available disulfoton labels to bracket risk levels associated with the various use patterns. No use data were provided by the registrant concerning the actual application rates that are commonly used for disulfoton.

- Generally, the use of PPE and engineering controls are not considered acceptable options for products sold for use by homeowners because they are not available, and/or inappropriate for the exposure scenario (e.g., acceptability rationale is based on a lack of enforcement, available PPE, and training).

- PHED values represent a handler wearing typical residential clothing attire of short sleeve shirt, short pants and no gloves.

- The number of rose bushes assumed for treatment per day by a homeowner is 50 rose bushes.

- The number of pots treated per day by a homeowner is 20 six inch pots.

- The number of ornamental shrubs or trees treated per day by a homeowner is assumed to be 25.

- The area treated with granulars for flower or vegetable gardens by a homeowner is assumed to be 1,000 ft^2. For pre-planting treatment of flower and vegetable gardens with a belly grinder, the treatment area is assumed to be 10,000 ft^2.

Residential Handler Exposure and Non-Cancer Risk Estimates

The calculations of daily dermal and inhalation exposure, short-term doses, and total short-term MOEs were made using the same formulas as presented earlier for occupational handlers.

Table 12 presents residential dermal and inhalation exposures associated with the handling of disulfoton. Table 13 presents the short-term dermal and inhalation risks as well as total MOEs resulting from those exposures.

Table 11. Residential Exposure Scenario Descriptions for the Use of Disulfoton

Exposure Scenario (Number)	Data Source	Standard Assumptions[a]	Comments[b]
Mixer/Loader/Applicator Descriptors			
Loading/Applying Granulars Using a Belly Grinder (1)	SOPs for Residential Exposure Assessments (12/97)	10,000 ft² for pre-planting of flower/vegetable gardens	**Baseline:** Dermal and hands data = ABC grades, inhalation = AB grade. Dermal 20-45 replicates; hands = 23 replicates; and inhalation = 40 replicates. Medium confidence for hands and dermal, and high confidence for inhalation. **PPE and Engineering Controls:** Not required for assessment.
Loading/Applying Using a Push-type Granular Spreader (2)	SOPs for Residential Exposure Assessments (12/97)	10,000 ft² for vegetable gardens, 1,000 ft² for flower gardens, and 25 shrubs	**Baseline:** Hands = C grade, and inhalation data = B grade. Hand = 15 replicates; dermal = 0-15 replicates; and inhalation = 15 replicates. Low confidence in hands and dermal data, and high confidence in inhalation data.. A 50% protection factor was used to "backcalculate" a short sleeved shirt value from long sleeve shirt data. **PPE and Engineering Controls:** Not required for assessment.
Loading/Applying Granulars by Spoon, Shaker Can, Measuring Scoop, or by Hand (3) (PHED values for Granular Bait Dispersed by Hand used as a surrogate for these application methods)	SOPs for Residential Exposure Assessments (12/97)	50 rose bushes, 1,000 ft² for vegetable gardens, 1,000 ft² for flower gardens, and 25 shrubs	**Baseline:** Dermal, hands and inhalation data = ABC grade. Hands, dermal and inhalation = 16 replicates. Medium confidence in all data. A 90% PF was applied to gloved hands data to backcalculate "no glove" hand exposure. **PPE and Engineering Controls:** Not required for assessment
Application of Insecticidal Spikes (4)	NA	NA	No Data

[a] Standard Assumptions based on HED estimates.

[b] "Best Available" grades are defined by HED SOP for meeting Subdivision U Guidelines. Best available grades are assigned as follows: matrices with grades A and B data and a minimum of 15 replicates; if not available, the grades A, B and C data and a minimum of 15 replicates; if not available, then all data regardless of the quality and number of replicates. Data confidence are assigned as follows:

High = grades A and B and 15 or more replicates per body part
Medium = grades A, B, and C and 15 or more replicates per body part
Low = grades A, B, C, D and E or any combination of grades with less than 15 replicates

NA = Not Applicable

Table 12: Residential Handler Dermal and Inhalation Exposures to Disulfoton at Baseline

Exposure Scenario (Scenario #)	Baseline Dermal Unit Exposure (mg/lb ai)[a]	Baseline Inhalation Unit Exposure (µg/lb ai)[b]	Range of Application Rates[c]	Crop Type or Target[d]	Amount Handled Per Day[e]	Daily Dermal Exposure[f] (mg/day)	Daily Inhalation Exposure (mg/day)[g]
Mixer/Loader/Applicator Exposure							
Loading/Applying Granulars with a Belly Grinder[h] (1)	110	62	0.2 lb ai/1000 ft²	Flower/Vegetable Gardens (pre-planting)	10,000 ft.²	220	0.12
			0.1 lb ai/1000 ft²			110	0.062
Loading/Applying Granulars with a Push Type Spreader (2)	3	6.3	0.00188 lb ai/bush	Roses	50 bushes	0.28	0.00059
			0.1125 lb ai/1,000 ft²[j]	Vegetable Gardens	10,000 ft.²	3.4	0.0071
			0.0313 lb ai/1,000 ft²[j]			0.94	0.0020
			0.3 lb ai/1,000 ft²	Flower Gardens	1,000 ft.²	0.9	0.0019
			0.1 lb ai/1,000 ft²			0.3	0.00063
			0.005 lb ai/1,000 ft²			0.015	0.000032
			1.32 lb ai/4 ft. shrub	Ornamental Shrubs/ Small Trees	25 shrubs	99	0.21
			0.01 lb ai/4 ft. shrub			0.75	0.0016
			0.00032 lb ai/4 ft. shrub			0.024	0.000050
Loading/Applying Granulars with a Spoon, Shaker Can, Measuring Scoop, or by Hand[i] (3)	430	470	0.00188 lb ai/bush	Roses	50 bushes	40	0.044
			0.1125 lb ai/1,000 ft²[j]	Vegetable Gardens	10,000 ft.²	480	0.53
			0.0313lb ai/1,000 ft²[j]			130	0.15
			0.3 lb ai/1,000 ft²	Flower Gardens	1,000 ft.²	130	0.14
			0.1 lb ai/1,000 ft²			43	0.047
			0.005 lb ai/1,000 ft²			2.2	0.0024
			1.32 lb ai/4 ft. shrub	Ornamental Shrubs/ Small Trees	25 shrubs	14,000	16
			0.01 lb ai/4 ft. shrub			110	0.12
			0.00032 lb ai/4 ft. shrub			3.4	0.0038
			0.00011 lb ai/6" pot	Potted Plants	20 pots	0.95	0.001
Application of Insecticidal Spikes (4)	No Data	No Data	No Data	No Data	No Data	No Data	No Data

Table 12: Residential Handler Dermal and Inhalation Exposures to Disulfoton at Baseline (Continued)

Footnotes:

a Baseline Dermal Unit Exposure represents short pants, short sleeved shirt, no gloves, and open mixing/loading.
b Baseline Inhalation Exposure represents no respirator.
c Application Rates are maximum rate values found on disulfoton labels (EPA Reg. No. 769-908, 572, 346, 33955-489, 4-253, 869-223, 3125-83).
d Crop Type or Target provides a general description of the intended uses of disulfoton. Separate categories are presented because of the distinct differences in application rates and amount handled.
e Daily Amount Handled values are from default estimates of square footage, or number of bushes shrubs or pots that could be treated in a single day for each exposure scenario.
f Daily Dermal Exposure (mg/day) = Unit Exposure (mg/lb ai) * Appl. rate * Amount Handled per day.
g Daily Inhalation Exposure (mg/day) = Unit Exposure (µg/lb ai) * (1mg/1000 µg) Conversion * Application Rate (lb ai/A) * Acres treated (acres/day).
h Residential application of disulfoton using a belly grinder are applicable for pre-plant treatment applications only.
i Unit exposure data for application of granules by hand were used as surrogate values for these scenarios.
j Application rates for small vegetable gardens are based on 24-inch row spacing (EPA Reg. No. 769-908).

Table 13: Residential Handler Short-term Risks from Disulfoton at Baseline

Exposure Scenario (Scenario #)	Crop Type or Target[a]	Amount Handled Per Day[b]	Application Rate	Baseline Dermal		Baseline Inhalation		Baseline Total
				Daily Dose (mg/kg/day)[c]	Short-term MOE[d]	Daily Dose (mg/kg/day)[c]	Short-term MOE[f]	Short-term MOE[g]
Mixer/Loader/Applicator Risks								
Loading/Applying Granulars with a Belly Grinder (1)	Flower/Veg. Gardens (pre-planting)	10,000 ft.^{2}	0.2 lb ai/1000 ft^2	3.1	0.1	0.0017	26	0.1
			0.1 lb ai/1000 ft^2	1.6	0.3	0.00089	51	0.3
Loading/Applying Granulars with a Push Type Spreader (2)	Roses	50 bushes	0.00188 lb ai/bush	0.0040	99	8.4E-6	5,300	99
	Vegetable Gardens	10,000 ft.^{2}	0.1125 lb ai/1,000 ft^2 [h]	0.048	8.3	0.00010	440	8.2
			0.0313 lb ai/1,000 ft^2 [h]	0.013	30	0.000029	1,600	30
	Flower Gardens	1,000 ft.^{2}	0.3 lb ai/1,000 ft^2	0.013	31	0.000027	1,700	31
			0.1 lb ai/1,000 ft^2	0.0043	93	0.0000090	5,000	93
			0.005 lb ai/1,000 ft^2	0.00021	1,900	4.6E-7	98,000	1,900
	Ornamental Shrubs/ Small Trees	25 shrubs	1.32 lb ai/4 ft. shrub	1.4	0.3	0.0030	15	0.3
			0.01 lb ai/4 ft. shrub	0.011	37	0.000023	2,000	37
			0.00032 lb ai/4 ft. shrub	0.00034	1,200	7.1E-7	63,000	1,200
Loading/Applying Granulars with a Spoon, Shaker Can, Measuring Scoop, or by Hand (3)	Roses	50 bushes	0.00188 lb ai/bush	0.58	0.7	0.00063	72	0.7
	Vegetable Gardens	10,000 ft.^{2}	0.1125 lb ai/1,000 ft^2 [h]	6.9	0.06	0.0076	5.9	0.06
			0.0313lb ai/1,000 ft^2 [h]	1.9	0.2	0.0020	21	0.2
	Flower Gardens	1,000 ft.^{2}	0.3 lb ai/1,000 ft^2	1.8	0.2	0.0020	23	0.2
			0.1 lb ai/1,000 ft^2	0.61	0.7	0.00067	67	0.6
			0.005 lb ai/1,000 ft^2	0.03	13	0.000034	1,300	13
	Ornamental Shrubs/ Small Trees	25 shrubs	1.32 lb ai/4 ft. shrub	200	0.002	0.23	0.2	0.002
			0.01 lb ai/4 ft. shrub	1.5	0.3	0.0017	26	0.3
			0.00032 lb ai/4 ft. shrub	0.049	8.1	0.000054	830	8.1
	Potted Plants	20 pots	0.00011 lb ai/6" pot	0.014	30	0.000014	3,200	29

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Table 13: Residential Handler Short-term Risks from Disulfoton at Baseline (Continued)

Exposure Scenario (Scenario #)	Crop Type or Target[a]	Amount Handled Per Day[b]	Application Rate	Baseline Dermal		Baseline Inhalation		Baseline Total
				Daily Dose (mg/kg/day)[c]	Short-term MOE[d]	Daily Dose (mg/kg/day)[e]	Short-term MOE[f]	Short-term MOE[g]
Application of Insecticidal Spikes (4)	Roses/Trees	No Data	No Data	No Data	No Data	No Data	No Data	No Data

Footnotes:

a. Crop Type or Target provides a general description of the intended use of various products containing disulfoton. Separate categories are presented because of the distinct differences in application rates and acres treated.
b. Amount Handled Per Day values are from default estimates of square footage or number of pots treated a single day for each exposure scenario of concern.
c. Daily Dermal Dose (mg/kg/day) = Daily Dermal Exposure (mg/day)/ Body weight (70 kg).
d. Short-term Dermal MOE = NOEL (0.4 mg/kg/day)/ Daily Dermal Dose (mg/kg/day).
e. Daily Inhalation Dose (mg/kg/day) = Daily Inhalation Exposure (mg/day)/ Body weight (70 kg).
f. Short-term Inhalation MOE = NOEL (0.045 mg/kg/day)/ Daily Inhalation Dose (mg/kg/day).
g. Total Short-term MOE = 1/ [(1/ Short-term Dermal MOE) + (1/ Short-term Inhalation MOE)].
h. Application rates for small vegetable gardens are based on 24-inch row spacing (EPA Reg No. 769-908).

Summary of Concerns for Homeowner-Handlers, Data Gaps, and Confidence in Exposure and Risk Estimates

Short-term dermal and inhalation risks for homeowner-handlers were assessed as well as the total risks associated with the handling of disulfoton

Handler Scenarios with Risk Concerns

The calculations of short-term dermal and inhalation risks indicate that **total short-term MOEs are greater than 100 at baseline for the following scenarios:**

(2) loading/applying with a push type granular spreader to flower gardens using an application rate of 0.005 lb ai/1000 ft^2

(2) loading/applying with a push type granular spreader to ornamental shrubs and small trees using an application rate of 0.00032 lb ai/four foot shrub

Data Gaps

Data gaps exist for the following scenario:

(4) applying insecticidal spikes to rose bushes, or ornamental shrubs and trees

Data Quality and Confidence in Assessment

Several issues must be considered when interpreting the non-occupational exposure risks

- PHED hands and dermal values are ranked in the low confidence category for application with a push type granular spreader.
- Factors used to calculate daily exposures to handlers (e.g. square footage treated per day, number of pots treated and number of shrubs or trees treated in a day) are based on the best professional judgement due to a lack of pertinent data.

Non-occupational Postapplication Exposures and Risks

Residential Postapplication Exposures and Assumptions

HED has determined that there are potential postapplication exposures to residents based on the following scenarios:

- pruning, cutting, and weeding treated ornamental shrubs and trees (including rose bushes),

- pruning, cutting, weeding and irrigating treated ornamental flowers;
- harvesting and non-harvest activities such as weeding, and hoeing of home vegetable crops; and
- incidental soil ingestion.

Based on these activities, four representative scenarios were evaluated using surrogate dislodgeable foliar residue data and assumptions about transfer of residues to the skin. Transplanting and pruning ornamentals and rose bushes was not evaluated because no data were available for application rates based on a unit area basis (i.e., application rates were lbs ai per bush/shrub or per foot of bush/shrub height. The surrogate assessments presented in Table 12 are based on the application rates recommended for field crops, and flower gardens on disulfoton labels, and assumptions regarding activity levels. These assumptions would be expected to bracket the reentry exposure levels anticipated from disulfoton use on these crop types. The four scenarios and assumptions addressed by the calculations are:

- Harvesting, cutting and pruning flower gardens;
- Irrigating flower gardens;
- Harvesting of home vegetable garden crops;
- Weeding, scouting and hoeing home vegetable crops; and
- Incidental soil ingestion of soil treated flower beds or vegetable garden beds (toddlers).

Data Source Descriptions for Scenarios Considered

A surrogate postapplication exposure assessment was conducted to determine potential risks for the previously mentioned representative residential scenarios.

Assumptions Used in Post application Exposure Calculations

The assumptions used in the calculations for residential postapplication risks include the following items:

- A dermal absorption value of 36 percent and a NOEL of 0.03 mg/kg/day were used in the assessment.
- Application rates used for the calculations:

-- Harvesting, cutting and pruning flower gardens: 13.0 lb ai/acre (0.3 lb ai/1,000 $ft^{2)}$

-- Irrigating flower gardens: 13.0 lb ai/acre (0.3 lb ai/1,000 $ft^{2)}$

-- Harvesting of home vegetable garden crops: 4.9 lb ai/acre (0.1125 lb ai/1,000 $ft^{2)}$

-- Weeding and hoeing home vegetable crops: 4.9 lb ai/acre (0.1125 lb ai/1,000 $ft^{2)}$.

- Transfer coefficients (Tc) are assumed to be 10,000 cm^2/hour for high contact activities in flower gardens such as harvesting, cutting, bundling, and pruning of flowers, 1,000 cm^2/hour for activities such as irrigating flower beds, weeding and scouting of low growing vegetables, 3,500 for harvesting activities of low growing vegetable crops, and 1,500 for non-harvest activities such as weeding, and hoeing of vegetable crops.

- On the day of application, it was assumed that 10 percent of the application rate was available as initial dislodgeable residue. The dissipation rate was estimated at 25 percent per day. This assumption takes into consideration the 2-day half-life of disulfoton and the soil incorporation application techniques.

- For the soil ingestion scenario, on the day of application, it was assumed that 20 percent of the application rate is located with the soil's uppermost 1 cm. The *Residential SOP's* specify a 100 percent assumption; however after disulfoton treatment followed by soil incorporation, the insecticide should be uniformly dispersed into the top 2 inches of soil.

- The assumed soil ingestion rate for children (ages 1-6 years) was assumed to be 100 mg/day.

Postapplication Exposure and Non-Cancer Risk Estimates

The equations used for the calculations in Table 14 were the same equations as previously presented in the occupational postapplication portion of the RED with the following changes:

- ED (exposure duration) in the calculation of daily dose is 2 hours per day rather than the 8 hours per day used in the occupational postapplication assessment.

- Application rates used in the residential assessment are described above.

- Adults were assumed to weigh 70 kg. Toddlers (3 years old), used to represent the 1 to 6 year old age group, were assumed to weigh 15 kg.

- Postapplication was assessed on the same day the pesticide is applied because it was assumed that the homeowner could be exposed to soil immediately after application. Therefore, postapplication exposures were based on day 0.

Table 15 presents the postapplication risks from the incidental soil ingestion by toddlers of soil treated with disulfoton. The following equations were used:

Incidental Soil Ingestion:

$$ADD = (SR_t * IgR * CF1) / BW$$

where:

ADD	=	average daily dose (mg/kg/day)
SR_t	=	soil residue on day "t" (μg/g), assuming average day of reentry "t" is day 0
IgR	=	ingestion rate of soil (mg/day), assumed to be 100 mg/day
CF1	=	weight unit conversion factor to convert the μg of residues on the soil to grams to provide units of mg/day (1E-6 g/μg)
BW	=	body weight (kg), assumed 15 kg for toddlers

and

$$SR_t = AR * F * (1-D)^t * CF2 * CF3 * CF4$$

where:

AR	=	application rate (lb ai/acre)
F	=	fraction of ai available in uppermost cm of soil (fraction/cm), assumed to be 20 percent based on soil incorporation into top 2 inches of soil after application
D	=	fraction of residue that dissipates daily (unitless)
t	=	postapplication day on which exposure is being assessed
CF2	=	weight unit conversion factor to convert the lbs ai in the application rate to μg for the soil residue value (4.54E8 μg/lb)
CF3	=	area unit conversion factor to convert the surface area units (ft^2) in the application rate to cm^2 for the SR value (2.47E-8 acre/cm^2 if the application rate is per acre)
CF4	=	volume to weight unit conversion factor to convert the volume units (cm^3) to weight units for the SR value (0.67 cm^3/g soil)[7]
t	=	postapplication day on which exposure is being assessed, assumed to be day 0

Summary of Residential Postapplication Risks

The acceptable MOE was assumed to be 100 for disulfoton. The resulting surrogate residential postapplication assessment indicates that:

- Disulfoton MOEs equal or exceed 100 for non-harvesting activities associated with agricultural crops (with a dermal transfer of 1,500 cm^2/hour) at the 20th day following applications at a rate of 4.9 pounds active ingredient per acre.

- Disulfoton MOEs equal or exceed 100 for harvesting activities associated with vegetable crops (with a dermal transfer of 3,500 cm^2/hour) at the 23rd day following applications at a rate of 4.9 pounds active ingredient per acre.

- Disulfoton MOEs equal or exceed 100 for high contact activities such as weeding, pruning, and bundling of flowers (with a dermal transfer of 10,000 cm^2/hour) at the 30th day following applications at a rate of 13 pounds active ingredient per acre.

- Disulfoton MOEs equal or exceed 100 for irrigating flower gardens harvesting activities associated with vegetable crops (with a dermal transfer of 1,000 cm^2/hour) at the 22nd day following applications at a rate of 13 pounds active ingredient per acre.

- The disulfoton MOEs for soil ingestion were greater than 100 for vegetable garden soil (application rate 4.9 lb ai/acre), and for flower garden soil (application rate 13.0 lb ai/acre).

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Table 14. Disulfoton Surrogate Postapplication Assessment (Range Finder) for Residential Application to Ornamentals and Low Growing Field Crops

Low Growing Field Crops applied at 4.9 lb ai/acre						Weeding, Pruning Flower Gardens - applied at 13 lb ai/acre					
		Non-harvesting		Harvesting				Harvesting, Weeding, Pruning, Bundling		Irrigating	
DAT[a]	DFR ($\mu g/cm^2$)[b]	Dermal Dose mg/kg/day	MOE	Dermal Dose mg/kg/day	MOE	DAT[a]	DFR ($\mu g/cm^2$)	Dermal Dose (mg/kg/day)[c]	MOE	Dermal Dose (mg/kg/day)[c]	MOE[d]
0	5.5	0.085	0.4	0.20	0.2	0	15	1.5	0.02	0.15	0.2
18	0.031	0.00048	63	0.0011	27	20	0.046	0.0048	6	0.00048	63
20	0.017	0.00027	110	0.00063	48	22	0.026	0.0027	11	0.00027	110
23	0.007	NA	NA	0.00027	110	30	0.0026	0.00027	110	NA	NA

a DAT is "days after treatment."
b Initial DFR = Application rate x Conversion factor (lb ai/acre = 11.209 $\mu g/cm^2$) x fraction of initial ai retained on foliage.

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Table 15. Residential Post-application Risks from Incidental Soil Ingestion of Disulfoton

Scenario	Receptor	Application Rate Per Treatment (AR) (lbs ai/A)[a]	SRt (ug/g)[b]	IgR (mg/day)	BW (kg)	ADD (mg/kg/day)[c]	MOE[d]
Incidental soil ingestion (Flower beds)	Toddler	13	20	100	15	0.00013	230
Incidental soil ingestion (Vegetable garden beds)	Toddler	4.9	7.4	100	15	0.000049	610

a Application rate for flower and vegetable gardens
b Soil residue (ug/g) = [AR (lbs ai/A) * 4.54E+8 ug/lb * 2.47E-8 A/cm^2 * 0.67 cm^3/g soil * 0.2/cm].
c Average daily dose (ADD) (mg/kg/day) = [SRt (ug/g) * IgR (mg/day) * g/1,000,000 ug] / [BW (kg)].
d MOE = NOEL (0.03 mg/kg/day) / ADD.

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References

1) U.S. EPA 1998. Disulfoton, PC0032501: Report of Hazard Identification Assessment Review Committee dated April 9, 1998.

2) U.S. EPA 1997. Iprodione LUIS Table for Exposure Assessors (PRD report dated 11/06/96 and report run date 06/12/97.

3) Disulfoton Labels.

4) Pesticide Handler Exposure Database Version 1.1 Surrogate Exposure Table. May 1997.

5) September 27, 1991 Memo from Peg Perreault, OREB Branch to Lois Rossi, Special Review and Reregistration Division. Subject: In Depth Review of Postapplication/Reentry Data Submitted to Support the Reregistration of Azinphos-Methyl (HED Project #s 0-467, 9-0972, 8-1164, 9-0811, and 9-0812).

6) U.S. EPA 1997. Standard Operating Procedures (SOPs) for Residential Exposure Assessments. December 1997.

cc: David Anderson, OPP/HED/RRB2
OREB Files

APPENDIX 5

Memorandum from Jerome Blondell to Jonathan Becker of HED (3/25/1998), Review of Disulfoton Incidence Reports

Jerome Blondell

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

March 25, 1998

MEMORANDUM

SUBJECT: Review of Disulfoton Incident Reports
DP Barcode D243921, Chemical #032501, Reregistration Case #0102

FROM: Jerome Blondell, Ph.D., Health Statistician
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Health Effects Division (7509C)

Monica F. Spann, M.P.H., Environmental Health Scientist
Chemistry and Exposure Branch 2
Health Effects Division (7509C)

THRU: Susan V. Hummel, Senior Scientist
Chemistry and Exposure Branch 2
Health Effects Division (7509C)

TO: Jonathan Becker, Environmental Health Specialist
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Health Effects Division (7509C)

BACKGROUND

The following data bases have been consulted for the poisoning incident data on the active ingredient Disulfoton (PC Code: 032501):

1) OPP Incident Data System (IDS) - reports of incidents from various sources, including registrants, other federal and state health and environmental agencies and individual consumers, submitted to OPP since 1992. Reports submitted to the Incident

Data System represent anecdotal reports or allegations only, unless otherwise stated. Typically no conclusions can be drawn implicating the pesticide as a cause of any of the reported health effects. Nevertheless, sometimes with enough cases and/or enough documentation risk mitigation measures may be suggested.

2) Poison Control Centers - as the result of Data-Call-Ins issued in 1993, OPP received Poison Control Center data covering the years 1985 through 1992 for 28 organophosphate and carbamate chemicals. Most of the national Poison Control Centers (PCCs) participate in a national data collection system, the Toxic Exposure Surveillance System which obtains data from about 70 centers at hospitals and universities. PCCs provide telephone consultation for individuals and health care providers on suspected poisonings, involving drugs, household products, pesticides, etc.

3) California Department of Food and Agriculture (replaced by the Department of Pesticide Regulation in 1991) - California has collected uniform data on suspected pesticide poisonings since 1982. Physicians are required, by statute, to report to their local health officer all occurrences of illness suspected of being related to exposure to pesticides. The majority of the incidents involve workers. Information on exposure (worker activity), type of illness (systemic, eye, skin, eye/skin and respiratory), likelihood of a causal relationship, and number of days off work and in the hospital are provided.

4) National Pesticide Telecommunications Network (NPTN) - NPTN is a toll-free information service supported by OPP. A ranking of the top 200 active ingredients for which telephone calls were received during calendar years 1984-1991, inclusive has been prepared. The total number of calls was tabulated for the categories human incidents, animal incidents, calls for information, and others.

DISULFOTON REVIEW

I. Incident Data System

Please note that the following cases from the IDS do not have documentation confirming exposure or health effects unless otherwise noted.

Incident#975-8

A pesticide incident occurred in 1994, when an individual ingested disulfoton and experienced diarrhea, ataxia, and tremors. No further information on the disposition of the case was reported.

Incident#999-104

A pesticide incident occurred in 1994, when an individual inhaled disulfoton and experienced respiratory symptoms. No further information on the disposition of the case was reported.

Incident#1097-1

A pesticide incident occurred in 1994, when a two and a half year old girl opened a product's package and put the product in her mouth. Specific symptoms were not mentioned. No further information on the disposition of the case was reported.

Incident#1358-1

A pesticide incident occurred in 1994, when an individual ingested disulfoton and experienced dizziness. No further information on the disposition of the case was reported.

Incident#3224-1

A pesticide incident occurred in 1996, when a thirty-five year old man was charged with murdering his six year old daughter and poisoning his estranged girlfriend and his two other children with disulfoton that was placed in their home. No further information on the disposition of the case was reported.

Incident#3768-1

A pesticide incident occurred in 1996, when a woman inhaled disulfoton that she had worked into the ground in the soil and experienced a sore throat and red bumps on her throat. No further information on the disposition of the case was reported.

Incident#5810-1

A pesticide incident occurred in 1997, when a farmer used disulfoton while planting cotton seeds about four years ago and

experienced peripheral neuropathy, lung problems, short-term memory, a hemorrhaging stomach, and pain in his legs and knees. No further information on the disposition of the case was reported.

Incident#6248-1

A pesticide incident occurred in 1997, when a father and his son applied disulfoton to birch trees eight to ten years earlier. The son experienced arthralgia and myalgia. No further information on the disposition of the case was reported.

II. Poison Control Center Data

Disulfoton was one of 28 chemicals for which Poison Control Center (PCC) data were requested. The following text and statistics are taken from an analysis of these data; see December 5, 1994 memo from Jerome Blondell to Joshua First.

The 28 chemicals were ranked using three types of measures: (A) number and percent occupational and non-occupational adult exposures reported to PCCs requiring treatment, hospitalization, displaying symptoms or serious life-threatening effects; (B) California data for handlers and field workers comparing number of agricultural poisonings to reported applications; and (C) ratios of poisonings and hospitalization for PCC cases to estimated pounds reported in agriculture for pesticides used primarily in agriculture.

A. Occupational and Non-occupational Exposure

There were a total of 1301 disulfoton cases in the PCC data base. Of these, 59 cases were occupational exposure; 48 (81.4%) involved exposure to disulfoton alone and 11 (18.6%) involved exposure to multiple chemicals, including disulfoton. There were a total of 499 adult non-occupational exposures; 468 (93.8%) involved this chemical alone and 31 (6.2%) were attributed to multiple chemicals.[1]

In this analysis, four measures of hazard were developed based on

[1] Workers who were indirectly exposed (not handlers) were classified as non-occupational cases.

the Poison Control Center data, as listed below.

1. Percent of all accidental cases that were seen in or referred to a health care facility (HCF).

2. Percent of these cases (seen in or referred to HCF) that were admitted for medical care.

3. Percent of cases reporting symptoms based on just those cases where the medical outcome could be determined.

4. Percent of those cases that had a major medical outcome which could be defined as life-threatening or resulting in permanent disability.

Exposure to disulfoton alone or in combination with other chemicals was evaluated for each of these categories, giving a total of 8 measures. A ranking of the 28 chemicals was done based on these measures with the lowest number being the most frequently implicated in adverse effects. Table 1 presents the analyses for occupational and non-occupational exposures.

Table 1: Measures of Risk From Occupational and Non-occupational Exposure to Disulfoton Using Poison Control Center Data from 1985-1992[a]

	Occupational Exposure	Non-occupational Exposure
Percent Seen in HCF		
Single chemical exposure	62.5 (68.2)	23.9(44.0)
Multiple chemical exposure	67.8(69.8)	24.6 (46.1)
Percent Hospitalized		
Single chemical exposure	26.7*[3] (12.2)	4.5 (9.9)
Multiple chemical exposure	27.5*[3] (14.3)	6.5 (12.6)
Percent with Symptoms		
Single chemical exposure	87.9*[7] (85.8)	59.2 (74.0)

Multiple chemical exposure	90.2*[6] (85.8)	62.1 (75.2)
Percent with Life-threatening Symptoms		
Single chemical exposure	3.0*[4] (0.0)	0.0 (0.0)
Multiple chemical exposure	2.4*[5] (0.5)	0.0 (0.05)

a Extracted from Tables 2, 3, 5 and 6 in December 5, 1994 memo from Jerome Blondell to Joshua First; number in parentheses is median score for that category.
* Top 25% of chemicals are ranked with a superscript of 1 to 7

Disulfoton had the third highest percent hospitalized for occupational cases. On life-threatening symptoms, disulfoton had the fourth highest percent for a single chemical exposure and fifth highest percent for multiple chemical exposure for occupational cases. However, these percentages were based on one life-threatening case. On percent with symptoms, disulfoton had the sixth highest percent for multiple chemical exposure and seventh highest percent for single chemical exposure for occupational cases. Among non-occupational cases with sufficient numbers reported, disulfoton did not rank in the top 25% on any of the measures.

B. Ratios of poisoning - California Data

The incidence of **systemic poisoning cases** in agricultural workers reported to the California was compared to the number of applications of disulfoton. Those calculations, along with the median score for a total of 29 pesticides, are presented in the Table 2 below.

Table 2: Systemic Poisonings/1,000 Applications in Selected Agricultural Workers Exposed to Disulfoton in California, 1982-1989[a]

Pesticide	Number of Appl.	Poisonings/1,000 Appl. (N) Primary Pesticide Only			Poisonings/1,000 Appl. (N) Multiple Pesticide Exposure		
		Handlers	Field Workers	Total	Handlers	Field Workers	Total
Disulfoton	31,226	.13 (4)	.10 (3)	.22 (7)	.26 (8)	.13 (4)	.38 (12)
Median		.21	.20	.41	.44	.50	1.02

a Extracted from Table A5 in December 5, 1994 memo from Jerome Blondell to Joshua First; number in parentheses is the observed number of poisoned cases.

Disulfoton had the eleventh highest ratio of field worker poisonings per 1,000 applications in California when exposures to mixtures were included and when mixtures were excluded (See Table 7 in the December 5, 1994 memo.)

C. Exposure in Children

A separate analysis of the number of exposures in children five years of age and under from 1985-1992 was conducted. For disulfoton, there were 743 incidents; 679 involved exposure to disulfoton alone and 64 involved other pesticides as well. Compared to 14 other organophosphates and carbamates that 25 or more children were exposed to, disulfoton cases were less than half as likely to be seen in a health care facility or require hospitalization. Symptoms also occurred less often for disulfoton, but there were two life-threatening cases reported in children under age six.

III. California Data - 1982 through 1995

Detailed descriptions of 29 cases submitted to the California Pesticide Illness Surveillance Program (1982-1995) were reviewed. In 18 of these cases, disulfoton was used alone and was judged to be responsible for the health effects. Only cases with a definite, probable or possible relationship were reviewed. Disulfoton ranked 60th as a cause of systemic poisoning in California. Two individuals were hospitalized between 1982 and 1995. Table 1 presents the types of illnesses reported by year. Table 2 gives the total number of workers that took time off work as a result of their illness and how many were hospitalized and for how long.

Table 1: Cases Due to Disulfoton Exposure in California Reported by Type of Illness and Year, 1982-1995

Year	Illness Type					
	Systemic[a]	Eye	Skin	Resp	Combination[b]	Total
1982	1	-	-	-	-	1
1983	3	-	-	-	-	3
1984	2	-	-	-	-	2
1985	2	-	-	-	-	2
1986	-	-	-	-	-	-
1987	-	-	-	-	-	-
1988	-	-	-	-	-	-
1989	-	-	-	-	-	-
1990	1	-	-	-	-	1
1991	2	-	-	-	-	2
1992	2	1	-	-	-	3
1993	-	1	1	-	-	2
1994	2	-	-	-	-	2
1995	-	-	-	-	-	-
Total	15	2	1	-	-	18

[a] Category includes cases where skin, eye, or respiratory effects were also reported

[b] Category includes combined irritative effects to eye, skin, and respiratory system

Table 2: Number of Persons Disabled (taking time off work) or Hospitalized for Indicated Number of Days After Disulfoton Exposure in California, 1982-1995.

	Number of Persons Disabled	Number of Persons Hospitalized
One day	2	-
Two days	1	-
3-5 days	2	1
6-10 days	1	-
more than 10 days	-	1
Unknown	1	-

A total of 15 persons had systemic illnesses or 83.3% of 18 persons. A total of 2 persons had eye illnesses or 13.3% of 18 persons. A variety of worker activities were associated with exposure to disulfoton as illustrated in Table 3 below.

Table 3: Illnesses by Activity Categories for Disulfoton Exposure in California, 1982-1995

Activity Category[a]	Illness Category					
	Systemic[b]	Eye	Skin	Resp	Combination[c]	Total
Application	4	-	1	-	-	5
Coinciden	3	-	-	-	-	3
Driftexp	1	-	-	-	-	1
Mixing/Loading	3	1	-	-	-	4
Othernon	4	1	-	-	-	5
Total	15	2	1	-	-	18

[a] Coinciden= coincidental; Driftexp= exposure to pesticide that has drifted from intended targets; Othernon= non-occupational exposure

[b] Category includes cases where skin, eye, or respiratory effects were also reported
[c] Category includes combined irritative effects to eye, skin, and respiratory system

According to the above activity categories, application and mixing/loading were associated with the majority of the exposures. These illnesses included symptoms of weakness, nausea, blurred vision, body aches, and twitching eyes.

IV. NPTN

On the list of the top 200 chemicals for which NPTN received calls from 1984-1991 inclusively, disulfoton was ranked 55th with 68 incidents in humans reported and 22 incidents in animals (mostly pets).

V. Conclusions

In California, disulfoton had the eleventh highest ratio (1982-1989) for cases when the pesticide was considered the primary cause of poisoning of fieldworkers per 1,000 applications. Disulfoton ranked third on percentage of occupational PCC cases requiring hospitalization and fourth on percentage of occupational cases with life-threatening symptoms.

VI. Recommendations

Measures to reduce risk to applicators and handlers of disulfoton should be consistent with other organophosphate and carbamates.

cc: Correspondence
Disulfoton file (chemical no. 032501)
SRRD - Dana Lateulere

RDI: BRSrSci:SHummel:

/OPP#

APPENDIX 6
Part 1
Water Assessment for the Disulfoton RED, Including Drinking Water Assessment

James Wolf

Part 2
Updated Draft Drinking Water Assessment an Draft Drinking Water Assessment for Disulfoton: Water Resources Assessment

James Wolf

PC Code 032501

MEMORANDUM DEC15 '97

SUBJECT: Water assessment for disulfoton RED including drinking water assessment

TO: Walter Waldrop
Special Review and Reregistration Division (7508W)

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THRU: Henry Nelson, Ph.D. H Nelson
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DATE: December 11, 1997

Summary and Conclusions

This memorandum presents an assessment of the potential to contaminate ground water and surface water from labeled uses of disulfoton. This assessment includes Tier I and II estimates of environmental concentrations (EECs) in surface water for disulfoton as applied to barley, cotton, potatoes, tobacco, and wheat, using several label application rates and methods. Surface water monitoring data available in STORET are also considered. The potential for disulfoton residues in ground water are assessed using the EFED ground water concentration screening model (SCI-GROW) and the monitoring data available in EFED's Pesticides in Ground Water Data Base (PGWDB) and EPA's STORET. The purpose of this analysis is to estimate environmental concentrations of disulfoton in surface water bodies and ground water for use in the human health and ecological risk assessment as part of the registration process. Environmental fate data base is incomplete. Limited data indicates that the degradates are much more persistent and mobile than parent disulfoton. The degradates, often as toxic as the parent compound, are not considered in this assessment due to lack of environmental fate data.

The GENEEC (Version 1.2; 5/13/95) model was used to generate Tier I EECs for disulfoton used on barley, cotton, potatoes, tobacco, and spring wheat. The maximum peak, 4-day average, 21-

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day, and 56-day average concentrations (EECs) were estimated using various combinations of application rates, numbers of applications, and application intervals (Table 1). GENEEC is a screening model used in Tier I (generic high run-off site) to estimate pesticide concentrations found in surface water up to 56 days. Thus, it provides an upper-bound concentration value which might be found in ecologically sensitive areas because of pesticide use. GENEEC is a single run-off event model, but can account for spray drift from multiple applications. GENEEC represents a 10-hectare field immediately adjacent to a 1-hectare pond that is 2-meters deep with no outlet. The pond receives a pesticide load from spray drift for each application plus what runs off in one rainfall event. The run-off event transports a maximum of 10% of the pesticide remaining in the top 2.5-cm of soil at the time the run-off event is assumed to occur into the pond. This amount can be reduced through soil sorption. The amount of pesticide remaining on the field in the surface 2.5 cm at the time of the run-off event occurs depends upon the application rate, number of applications, interval between application, incorporation depth, and degradation rate in the soil. Spray drift is determined by method of pesticide application (5% for aerial spray; 1% for ground spray). GENEEC and PRZM simulations were both made with the typical and maximum application rates, maximum number of yearly applications, and the shortest recommended application interval.

The Tier II EEC assessment uses a single site, or multiple single sites, which represents a high-end exposure scenario from pesticide use on a particular crop or non-crop use site. The EECs for disulfoton were generated for multiple crop scenarios using PRZM3 (Carsel, 1997) which simulates the erosion and run-off from an agricultural field and EXAMS 2.97.5 (Burns, 1997) which simulates the fate in a surface water body. PRZM3 and EXAMS estimates for a single site, over multiple years, EECs for a 1 ha surface area, 2 m deep pond draining an adjacent 10 ha barley, cotton, potato, tobacco, or spring wheat field. Each scenario, or site, was simulated for 27 to 40 (depending on data availability) years. EFED estimated 1 in 10 year maximum peak, 4-day average, 21-day average, 60-day average, 90-day, annual average concentrations. Disulfoton (Di-Syston) formulations were based upon registered uses on the specific crops. The application rates, numbers, and intervals are listed in Table 2 and environmental fate inputs are listed in Table 4. Spray drift is determined by method of pesticide application (5% for aerial spray; 1% for ground spray). The Tier II PRZM/EXAMS EECs for disulfoton are listed in a Table 2.

The PRZM/EXAMS EECs are generated for high exposure agricultural scenarios and represent one in ten year EECs in a stagnant pond with no outlet that receives pesticide loading from an adjacent 100% cropped, 100% treated field. As such, the computer generated EECs represent conservative screening levels for ponds, lakes, and flowing water and should only be used for screening purposes. The EECs have been calculated so that in any given year, there is a 10% probability that the maximum average concentration of that duration in that year will equal or exceed the EEC at the site. Tier II upper tenth percentile EECs are presented in Table 2.

The disulfoton scenarios are representative of high run-off sites for barley in the Southern Piedmont of Virginia (MLRA 136), cotton in the Southern Mississippi Valley Silty Uplands of Mississippi (MLRA 134), potatoes in the New England and Eastern New York Upland of

Maine (MLRA 144A), tobacco in Southern Coastal Plain of North Carolina (MLRA 133A), and spring wheat in the Rolling Till Prairie of South Dakota (MLRA 102A). The scenarios chosen are professional best judgement sites expected to produce run-off greater than would be expected at 90% of the sites where the appropriate crop is grown.

Table 1. Surface water concentrations estimates from GENEEC (Version 1.2) for disulfoton.

Crop	Application Rate/Number/ Interval (lb.ai./ac/#/days)	Drift (%)	Depth Inc.	Peak	4-day	21-day	56-day
Barley	1.005/2/21	0	0.0	28.0	27.5	25.1	21.6
Barley	0.826/2/21	5	0.0	23.0	22.6	20.6	17.8
Cotton	1.009/3/21	0	2.5	13.0	12.7	11.6	10.0
Cotton	3.270/3/21	0	2.5	42.0	41.2	37.6	32.5
Potatoes	4.005/2/14	0	2.5	48.7	47.8	43.7	37.7
Potatoes	9.390/2/14	0	2.5	114.2	112.2	102.4	88.5
Potatoes	4.000/2/14	0	0.0	121.6	119.5	109.0	94.2
Potatoes	9.390/2/14	0	0.0	285.4	280.4	255.9	221.2
Tobacco	8.170/1/0	0	2.5	57.6	56.6	51.6	44.6
Tobacco	4.005/1/0	0	2.5	28.2	27.7	25.3	21.9
Tobacco	16.33/1/0	0	2.5	115.1	113.1	103.2	89.2
Spr. Wheat	1.005/1/0	0	0.0	17.7	17.4	15.9	13.7
Spr. Wheat	0.637/1/0	0	0.0	11.2	11.0	10.1	8.7
Spr. Wheat	0.637/1/0	5	0.0	12.4	12.2	11.1	9.6

The SCI-GROW (Screening Concentration in Ground Water) screening model developed in EFED (Barrett, 1997) was used to estimate potential ground water concentrations for disulfoton parent under hydrologically vulnerable conditions. The maximum disulfoton ground water concentration predicted by the SCI-GROW using the maximum rate 9.39 lb. a.i./ac and 2 applications was 0.83 µg/L.

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Table 2. Tier II Upper Tenth Percentile EECs for Disulfoton Used on barley, cotton, potatoes, tobacco, and spring wheat for several application rates and management scenarios estimated using PRZM3/EXAMs.

Crop	Disulfoton Application Rate/Number/Interval/Incorp. Depth lb.ai../ac/ #/ days/ inches	Concentration (µg/L) (1-in-10 annual yearly maximum value)					
		Peak	96-Hour Avg.	21-Day Avg.	60-Day Avg.	90-Day Avg.	Annual Avg.
Barley	1.00/2/21/0	17.92	17.48	15.85	13.95	12.59	7.12
Barley	0.83/2/21/0	18.02	17.62	16.50	14.75	13.56	7.75
Cotton	1.01/3/21/2.5	16.75	16.35	14.98	13.39	12.63	7.47
Cotton	3.27/3/21/2.5	54.24	52.97	48.54	43.35	40.91	24.20
Potatoes	4.01/2/14/2.5	22.08	21.62	20.21	17.78	16.13	7.98
Potatoes	9.39/2/14/0	117.00	114.50	106.50	93.54	85.92	43.24
Potatoes	4.00/2/14/0	49.76	48.69	45.44	39.84	36.59	18.42
Potatoes	9.39/2/14/2.5	51.78	50.69	47.39	41.69	37.83	18.71
Tobacco	8.17/1/0/2.5	98.19	95.71	87.30	75.11	68.75	40.33
Tobacco	4.00/1/0/2.5	20.85	20.27	18.24	15.70	14.38	8.17
Tobacco	16.33/1/0/2.5	85.02	82.66	74.36	64.00	58.62	33.29
Spr.Wheat	1.00/1/0/0	7.90	7.72	7.08	6.03	5.51	3.08
Spr.Wheat	0.64/1/0/0	10.20	9.96	9.44	8.32	7.71	4.77

The fate of disulfoton in surface water and ground water and the likely concentrations cannot be modeled with a high degree of certainty since no data are available for the aerobic and anaerobic aquatic degradation rates, and anaerobic soil metabolism. The large degree of latitude available in the disulfoton labels also allows for a wide range of possible application rates, total amounts, application methods, and intervals between applications. However, considering the relatively rapid rate of microbial degradation in the soil (<20 day aerobic soil metabolism half-life) and direct aquatic photolysis in(surface water, the disulfoton parent may degrade fairly rapidly. However, peak concentrations appear capable of being quite high, when high application rates used.

Ground water and surface water monitoring data tends to confirm fairly rapid degradation, but potentially high peak values. The majority of samples had low levels (<16 µg/L) of disulfoton

residues. However, there were indications of some high concentrations (may be a reflection of how the data were reported) as the disulfoton concentrations in the monitoring were not always known. This is because the detection limit was not adequate (extremely high) or specified, and/or the limit of quantification was not stated or extremely high. Disulfoton concentrations were simply given as less than a value. Therefore, considerable uncertainty exists with respect to the monitoring data (especially the STORET data). Although, no assessment can be made for degradates due to lack of data, limited data suggests that the degradates are more persistent (>200 days) than disulfoton, suggesting their presence in water for an longer period of time than the parent. The degradates also appear to be more mobile than the parent compound.

Pesticide Use and Application Rates

Disulfoton is an insecticide used on a variety of food and non-food commodities. Disulfoton is formulated as 15% granules, 8% emulsifiable systemic, 95% cotton seed treatment, systemic granules (1, 2, 5, 10%), and 68% concentrate for formulating garden products.

Applications are generally soil applied: in-furrow, broadcast, or row treatment followed by 2-3 inch soil incorporation. It can also be applied as a foliar treatment and in irrigation water. Cotton seeds can also be directly treated and planted. Disulfoton can be applied in multiple applications, typically up to three, at intervals from 7 to 21 days depending upon the crop. The application rates, number of applications, and interval between applications used are summarized in Tables 1 and 2.

The application rates selected (Tables 1 and 2) were based upon information submitted by the registrant, analysis conducted by BEAD, and the disulfoton (Di-Syston) labels. Four factors went into selecting the application rate: 1) the range of ounces or pounds a.i.; 2) the area or length of row per acre (which is influenced by row spacing); 3) the number of applications; and 4) the application interval. The maximum rate (ounces or pounds a.i. per crop simulated) and the shortest application interval were selected. The shorter the distance between the crop rows the greater the application rate on an area basis. Two row spacing values were generally selected; one based on a near-the-maximum number of rows indicated by the label, and second based on the row spacing given in the label example (e.g., tobacco, page 8 of 14; 20 to 40 oz. per 1000 feet of row (for "any row spacing") or 13.3 to 26.7 lb. per acre or with a 48 inch row spacing). The label indicated that "any row spacing" could be as narrow as 6 inches. The narrowest row spacing used in this assessment was 12 inches. Thus a crop like tobacco had a range of application rates of 4.005 to 16.33 lb. a.i. per acre.

Modeling Scenarios

Surface Water: The sites selected are currently used by EFED to represent a reasonable "at risk" soil for the region or regions being considered. The scenarios selected represent high-end exposure sites. The sites are selected so that they generate exposures larger than for most sites (about 90 percent) used for growing the selected crops. An "at risk" soil is one that has a high

potential for run-off and soil erosion. Thus, these scenarios are intended to produce conservative estimates of potential disulfoton concentrations in surface water. The crop, MLRA, state and site conditions for the scenarios considered are given in Table 3.

Ground Water: The SCI-GROW (Screening Concentration in Ground Water) screening model developed in EFED (Barrett, 1997) was used to estimate potential ground water concentrations for disulfoton parent under hydrologically vulnerable conditions.

Table 3. Crop, location, soil and hydrologic group for each modeling scenario.

Crop	MLRA[1]	State	Soil Series	Soil Texture	Hydrologic Group	Period (Years)
Barley	136	VA	Gatton	sandy clay loam	C	27
Cotton	134	MS	Loring	silt loam	C	36
Potatoes	133A	ME	Emporia	loamy sand	C	36
Tobacco	144A	NC	Loring	silt loam	C	36
Spr.Wheat	102A	SD	Peever	clay loam	C	40

[1]MLRA is major land resource area (USDA, 1981).

Environment Fate and Chemistry

The environmental fate and chemistry data base for disulfoton is incomplete for the parent compound (Table 4). Fate data are not available for the degradation products. The major routes of dissipation are microbial degradation in an aerobic soil and aqueous photolysis and soil photolysis. Data are unavailable for anaerobic soil conditions and the aquatic environment. Disulfoton is stable to hydrolysis at the three pH values tested. The overall results of these mechanisms of dissipation appear to indicate that disulfoton has low to moderate persistence in the environment. Limited data suggests that the degradates are much more persistent.

Hydrolysis: The reported hydrolysis half-lives are 1174 days, 323 days, and 231 days in sterile aqueous buffered solutions at pH's 4, 7, and 9, respectively, for a 30 day study. Consequently, disulfoton is essentially stable to abiotic degradation.

Photolysis: Disulfoton degrades rapidly under aqueous photolysis. The half-life for aqueous photolysis (corrected for the dark control) is 3.87 days in a pH 5 buffered solution. The soil photolysis half-life was (corrected for the dark control) 2.4 days. For the purpose of modeling (in the water body), disulfoton the water photolysis rate was considered.

Soil and Aquatic Metabolism: The aerobic soil metabolism half-life of disulfoton was observed to be between <3 and 15.6 days . The aerobic soil metabolism half-life used in modeling is the upper 90% confidence bound on the mean of half-lives for three aerobic soils tested in the laboratory.

Soil Water Partition Coefficient: Adsorption/desorption studies of disulfoton indicated that it is slightly mobile to somewhat mobile depending on the soil. The Freundlich K_{ads} (organic carbon normalized Freundlich Kads) values were 6.9 (449), 4.8 (888), 4.5 (386), and 9.7 (483) for silt loam, sand, clay loam, and sandy loam textured soils, respectively. The average organic carbon normalized Freundlich Kads was estimated to be 551.5 ml/g soil carbon. The Koc model generally appears to be appropriate. Fate properties were generally selected to represent conservative conditions (e.g., maximum persistence and mobility). Chemical parameters used in the modeling of disulfoton are provided in Table 4.

Table 4. Disulfoton fate properties and values used in (GENEEC, PRZM3/EXAMs) modeling.

Parameter	Value	Source
Molecular Weight	274.39	EFED One-liner 05/21/97
Water Solubility	15 mg/l @20	EFED One-liner 05/21/97
Henry's Law Coefficient	2.60 atm-m3/mol	EFED One-liner 05/21/97
Partition Coefficient (Koc)	551.5	EFED One-liner 05/21/97
Vapor Pressure	4.33E-06 mmHg	EFED One-liner 05/21/97
Hydrolysis Half-lives @ pH 4 pH 7 pH 9	1174 days 323 " 231 "	EFED One-liner 05/21/97
Aerobic Soil Half-life	19.39 days (0.03575/d)	Upper 90% confidence bound on the mean of half-lives for the three aerobic soils tested in the laboratory EFED One-liner 5/23/97; EFED "draft" RED
Water Photolysis	3.87 days (pH = 5) (0.179/d)	EFED One-liner 05/21/97
Aerobic Aquatic Half-life	no data	

Modeling Procedure

GENEEC was run for a number of crops and pesticide application rates, numbers, intervals, and methods (Tables 1) and fate properties are summarized in Table 4.

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The PRZM3 simulations were run for a period of 36 years on cotton, potatoes, and tobacco, beginning on January 1, 1948 and ending on December 31, 1983. Barley was run for 27 years (1956-1983) and spring wheat was run for 40 years (1944-1983). Scenario information is summarized in Table 3. The EXAMS loading (P2E-C1) files, a PRZM3 output, were pre-processed using the EXAMSBAT post-processor. EXAMS was run for the 27-40 years using Mode 3 (defines environmental and chemical pulse time steps). For each year simulated, the annual maximum peak, 96-hour, 21-day, 60-day, 90-day values, and the annual means were extracted from the EXAMS output file REPORT.XMS with the TABLE20 post-processor. The 10 year return EECs (or 10% yearly exceedance EECs) listed in Table 2 were calculated by linear interpolation between the third and fourth largest values by the program TABLE20. Cumulative frequency plots for each scenario are provided in Appendix I.

Modeling Results

The Tier I upper-bound estimates of disulfoton concentrations in surface water using the GENEEC screening model results in minimum peak concentration of 11.2 µg/L for spring wheat in South Dakota and a maximum of 285.4 µg/L for potatoes in Maine. The minimum and maximum 56-day concentrations were 8.7 and 221.2 µg/L for wheat and potatoes, respectively.

In the Tier II assessment, the overall upper 90% confidence bound on the estimated multiple year mean concentrations of disulfoton in a farm pond over multiple years simulated ranged from 3.08 µg/L for a single maximum application (@1.00 lb. ai. ac) to spring wheat in South Dakota to 43.24 µg/L for potatoes in Maine with the two applications at the maximum application rate (@9.39 lb. ai./ac). These upper 90% confidence bounds are the best values to use in cancer risk assessments as they are the best estimates of lifetime mean concentrations. Maximum, or peak, estimated concentrations of 117.0 µg/L occurred for two 9.39 lb. ai/ac applications of disulfoton to potatoes. For the other scenarios, the maximum concentrations ranged from 7.72 to 98.19 µg/L. The Tier II modeling results from PRZM/EXAMs fall within the range of concentrations for surface water reported in the STORET database (0.0 to 100 µg/L). Because in STORET many samples were listed as "actual value is known to less than given value", the maximum concentration of samples was not always known (see STORET discussion). The modeling results therefore cannot be confirmed by the monitoring data.

The GENEEC and PRZM/EXAMs estimated disulfoton residue concentrations in surface water appear to be strongly related to application rate, number of applications, application interval, and method of application.

The maximum disulfoton ground water concentration predicted by the SCI-GROW model (using the maximum rate 9.39 lb. a.i./ac and 2 applications) was 0.83 µg/L.

Disulfoton Monitoring Data

The Pesticides in Ground Water Data Base (USEPA, 1992) summarizes the results of a number

of ground water monitoring studies conducted which included disulfoton (and disulfoton degradates D. sulfone and D. sulfoxide). Monitoring, with no detections (limits of detections ranged from 0.01 to 6.0 µg/L), have occurred in the follow states (number of wells): AL (10), CA (974), GA (76), HI (5), IN (161), ME (71), MS (120), MN (754), OK (1), OR (70), and TX (188). Disulfoton residues were detected in ground water in Virginia and Wisconsin. In Virginia, 6 of the 12 wells sampled had disulfoton detections ranging from 0.04 to 2.87 µg/L. In Wisconsin, 14 of 26 wells sampled had disulfoton residues ranging from 4.0 to 100.0 µg/L. One hundred twenty wells were analyzed in MS for degradates D. sulfone and D. sulfoxide and 188 wells were analyzed in TX for D. sulfone. Limits of detection were 3.80 and 1.90 µg/L for the sulfone and sulfoxide degrade, respectively, in MS. There were no degradates reported in these samples.

Several limitations for the monitoring data should be noted. These limitations include: the use of different limit of detections between studies, lack of information concerning disulfoton use around sampling sites, and lack of data concerning the hydrogeology of the study sites.

STORET: STORET is a computerized data base utility maintained by the Office of Water, EPA for the STOrage and RETrieval of chemical, physical, and biological data pertaining to the quality of waterways within and contiguous to the United States. Geographical, political, and descriptive information concerning sites where data have been collected, known as "stations" are the base to which data is attached. The data contained in STORET are collected, stored, and used by a variety of Federal, State, Interstate, and local government agencies. These data are generally made freely available to every citizen under the Freedom of Information Act (FOIA) or by direct access through a number of mechanisms.

All data in STORET are owned by the user-agencies (data owners). Incoming data to the system are edited for errors and inconsistencies, however, the owners of the data have the primary responsibility for its content. Because these studies are conducted by a variety of individuals for a number of reasons, the detection limits can be quite variable. Additionally, the STORET system imposes a structure and some minimum content requirements on incoming data, e.g., station identifier data, sample data temporal and spatial information, parametric data. Each agency which submits data to STORET manages its own data for its own purposes, and because their needs vary widely, the STORET data they maintain varies widely from one agency to the next. The actual use of disulfoton where the samples were collected is also not known. Therefore, it is often recommended that prior to use of STORET data for regulatory purposes the circumstances under which it was collected be ascertained.

A search of the EPA's STORET (10/16/97) data base resulted in the identification of disulfoton residues at a number of locations. These results are summarized in Table 5. Some clarification about these data are necessary. First, the data base indicates that five analytical methods were used (39010, 39011, 81888, 82617, 82677 - STORET code numbers) with a variety of detection limits. These results also are reported with a number of "qualifiers" including: 1) actual value is known to less than value given, 2) analyzed but not detected, 3) estimated value - value not

accurate. For example, the maximum values given in Table 5 for the stream samples (for each method) are 16.00, 100.00, 1.00, and 0.21 µg/L. From this we know that disulfoton residues maybe present but at values less than the given value (maybe even 0.0). Thus, when a value of 100.00 µg/L is reported, we know the actual value is less than 100, but we don't know how much less.

The means are also not true means, since they are determined from the imprecise values as noted above High detections limits may not preclude the possible presence of residues at levels less than the limit of detection. (e.g., if the detection limit is high disulfoton may be present although not identified, actual concentration were not always given, and many 0 values) but only given to provide an indication of the disulfoton detections observed. To put this in perspective, of the more than 15000 samples in the STORET data base, only one value was listed as less than 250 µg/L, approximately 800 were listed as less than 100 µg/L, and 3 were less than 50 µg/L. The remaining values were less than 16 µg/L with the majority of values being less than 1 (0 to 1). Minimum values reported tend to range between 0.02 and 0.1 µg/L.

STORET also reports disulfoton residues in ground water (Table 5). The range of disulfoton concentrations in ground water samples indicate values could be nearly as high as 100.00 and 250.00 µg/L. The exact concentration of these wells is not known, but it is unlikely that concentrations were actually this high (see above). The concentrations of disulfoton reported in ground water from monitoring studies (PGWDB and STORET) are sometimes greater than the maximum ground water concentrations predicted (0.83 µg/L) by the SCI-GROW model (using 9.39 lb. a.i./ac, 2 applications). But again, many of these "high" values are reported as "less then". The preponderance of values were less than 1.00 µg/L.

Table 5. Summary of disulfoton detections in STORET.

Type of Water Body	# of Samples	Analytical Method	Concentration (µg/L)	
			mean	range
Stream	1940	39010/39011[1]	0.41	0.00-16.00
"	253	81888[2]	1.67	0.00-100.00
"	39	82617[3]	0.88	0.05-1.00
:	5164	82677[4]	0.03	0.00-0.21
Lakes	270	39011	0.011	0.01-0.10
"	2	81888	0.095	0.05-0.14
"	20	82617	1.00	1.00-1.00
"	52	82677	0.031	0.00-0.10
Springs	24	39011	0.018	0.01-0.10
"	15	81888	6.81	0.05-100.00
"	134	82677	0.03	0.008-0.060
Reservoirs	2	81888	0.15	0.10-0.20
Estuary	4	39011	0.01	0.01
"	1	82677	0.017	0.02
Canals	2	39011	0.50	0.5
"	215	81888	0.077	0.03-0.3
Wells	383	39010	1.52	1.00-100.00
"	951	39011	0.26	0.01-1.00
"	3108	81888	25.23	0.00-250.00
"	44	82617	0.74	0.03-1.00
"	2559	82677	0.025	0.00-0.14

[1]39010/39011 Flame Photometer Whole Water: disulfoton/disyston

[2]81888 Disulfoton Whole Water

[3] 82617 Disulfoton Total Recoverable whole water

[4] 82677 Disulfoton "filtered 0.07 um" Total Recoverable whole water

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Limitations of this Modeling Analysis

There are several factors which limit the accuracy and precision of this modeling analysis including the selection of the high-end exposure scenarios, the quality of the data, the ability of the model to represent the real world, and the number of years that were modeled. There are additional limitations on the use of these numbers as an estimate of drinking water exposure. Degradation/metabolism products were also not considered due to lack of data.

The GENEEC is a screening model developed by EFED to be used in Tier I to estimate pesticide concentrations found in surface water for use in ecological risk assessments. It therefore is intended to provide an upper-bound concentration value which might be found in ecologically sensitive areas because of pesticide use. GENEEC is a single run-off event model, but can account for spray drift from multiple applications. GENEEC represents a 10-hectare field immediately adjacent to a 1-hectare pond that is 2-meters deep with no outlet. The pond receives spray drift from each application plus the one run-off event. The run-off event transports a maximum of 10% of the pesticide remaining in the top 2.5 cm of soil at the time of the assumed run-off event into the pond. This amount can be reduced through degradation in the field and the soil sorption. Spray drift is determined by method of pesticide application: 0-percent when applied as broadcast, in-furrow, 1% for ground spray, and 5% for aerial spray. Another major limitation in the current GENEEC simulations is that the aquatic (microbial) degradation pathway was not considered due to lack of data. Direct aquatic photolysis was however included.

Tier II scenarios are also ones that are likely to produce high concentrations in aquatic environments. The scenarios were intended to represent sites that actually exist and are likely to be treated with a pesticide. These sites should be extreme enough to provide a conservative estimates of the EEC, but not so extreme that the model cannot properly simulate the fate and transport processes at the site. Currently, sites are chosen by best professional judgement to represent sites which generally produce EECs larger than 90% of all sites used for that crop. The EECs in this analysis are accurate only to the extent that the sites represent the hypothetical high exposure sites. The most limiting aspect of the site selection is the use of the "standard pond" which has no outlet. It also should be noted that the standard pond scenario used here would be expected to generate higher EECs than most water bodies; although, some water bodies would likely have higher concentrations (e.g., a shallow water bodies near agriculture fields that receive direct run-off from the treated field).

The quality of the analysis is also directly related to the quality of the chemical and fate parameters available for disulfoton. Acceptable data are available, but rather limited. Data were not available for degradates and the aquatic aerobic metabolism rate was not known, but estimated. The measured aerobic soil metabolism data is limited, but has sufficient sample size to establish an upper 90% confidence bound on the mean of half-lives for the three aerobic soils tested in the laboratory (EFED One-liner, 1997). The use of the 90%-upper bound value may be

sufficient to capture the probable estimated environmental concentration when limited data are available.

The models themselves represent a limitation on the analysis quality. These models were not specifically developed to estimate environmental exposure in drinking water so they may have limitations in their ability to estimate drinking water concentrations. Aerial spray drift reaching the pond is assumed to be 5 percent of the application rate. No drift was assumed for broadcast or in-furrow applications. Another limitation is the lack of field data to validate the predicted pesticide run-off. Although, several of the algorithms (volume of run-off water, eroded sediment mass) are validated and understood, the estimates of pesticide transport by PRZM3 has not yet been fully validated. From limited analysis it appears that PRZM3 generates pesticide loadings that are somewhat higher than really occur. This would result in conservative EEC estimates. Other limitations of the models are the inability to handle within site variation (spatial variability), crop growth, and the overly simple soil water balance. Another limitation is that 27 to 40 years of weather data was available for the analysis. Consequently there is a 1 in 27, 36, or 40 chance that the true 10% exceedance EECs are larger than the maximum EEC in the analysis. If the number of years of weather data were increased, it would increase the level of confidence that the estimated value for the 10% exceedance EEC was close to the true value.

EXAMS is primarily limited because it is a steady-state model and cannot accurately characterize the dynamic nature of water flow. A model with dynamic hydrology would more accurately reflect concentration changes due pond overflow and evaporation. Thus, the estimates derived from the current model simulates a pond having no-outlets, flowing water, or turnover. Another major limitation in the current EXAMs simulations is that the aquatic (microbial) degradation pathway was not considered due to lack of data. Direct aquatic photolysis was however included.

Another important limitation of the Tier I and II EECs for drinking water exposure estimates is the use of a single 10 hectare drainage basin with a 1 hectare pond. It is unlikely that this small of a system accurately represents the dynamics in a watershed large enough to support a drinking water utility. It is unlikely that an entire basin, with an adequate size to support a drinking water utility would be planted completely in a single crop or be represented by scenario being modeled. The pesticides would more than likely be applied over several days to weeks rather than on a single day. This would reduce the magnitude of the conservative concentration peaks, but also make them broader, reducing the acute exposure, but perhaps increasing the chronic exposure.

Monitoring data is limited by the lack of correlation between sampling date and the use patterns of the pesticide within the study's drainage basin. Additionally, the sample locations were not associated with actual drinking water intakes for surface water nor were the monitored wells associated with known ground water drinking water sources. Also, due to many different analytical detection limits, no specified detection limits, or extremely high detection limits, a detailed interpretation of the monitoring data is not always possible.

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cc:

D. Lateulere, SRRD, 7508W
B. Edwards, RD, 7505C
D. Locke, HED, 7509C

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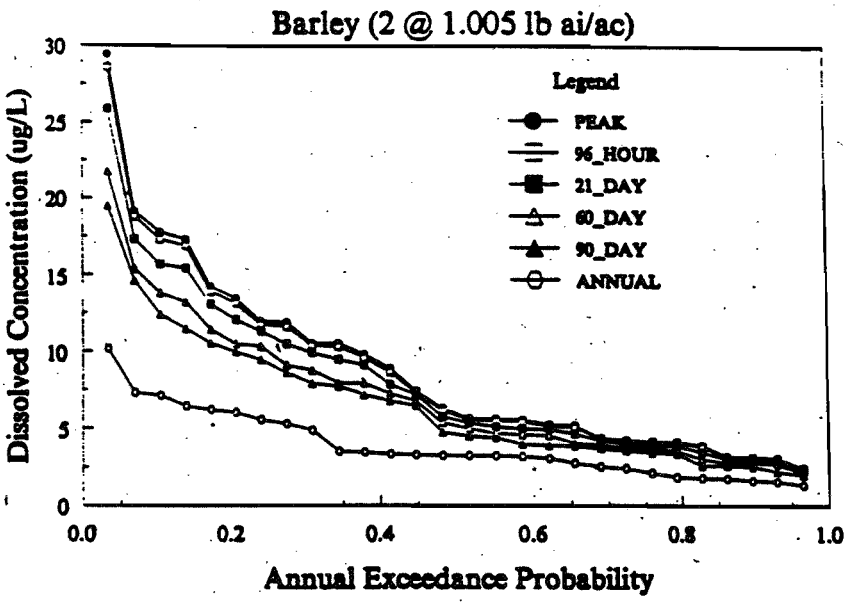
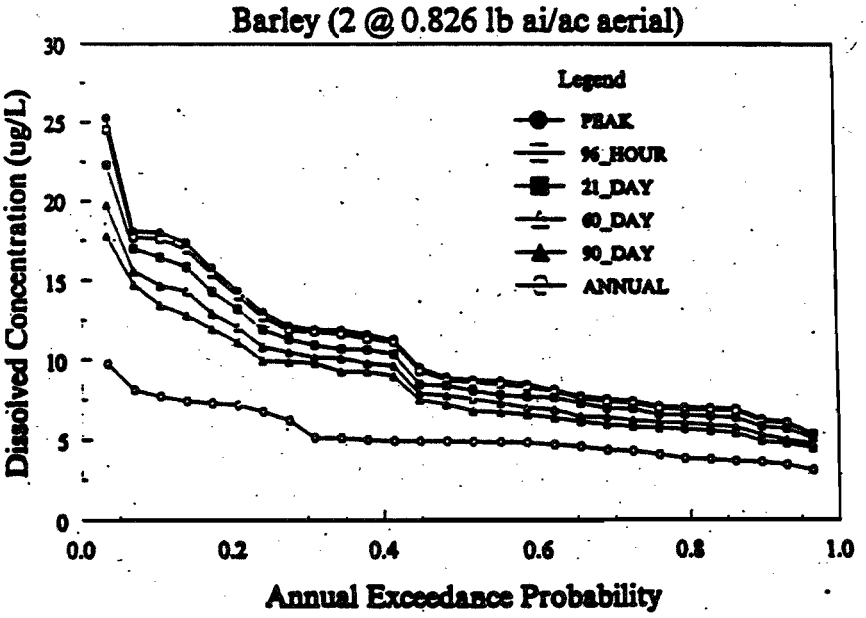
Appendix I. Cumulative frequency plots for disulfoton surface water EECs.





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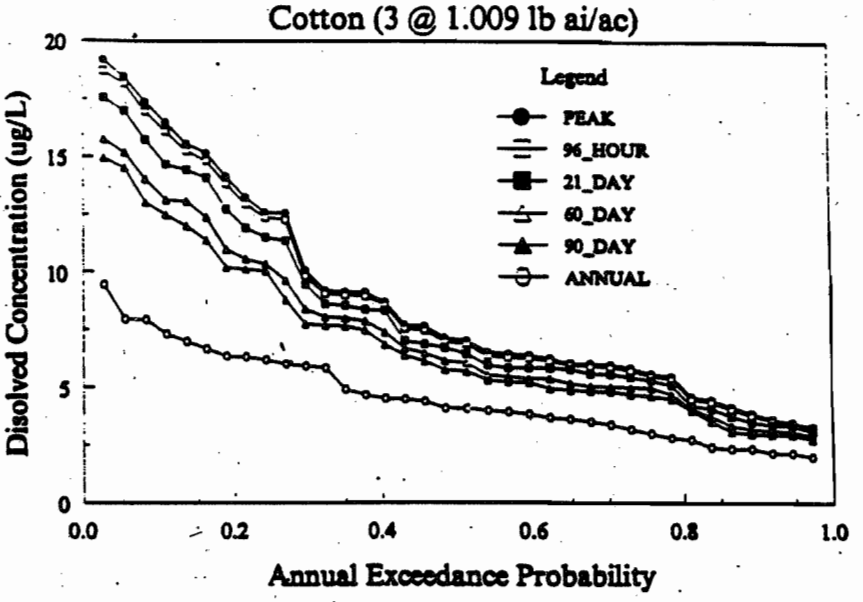

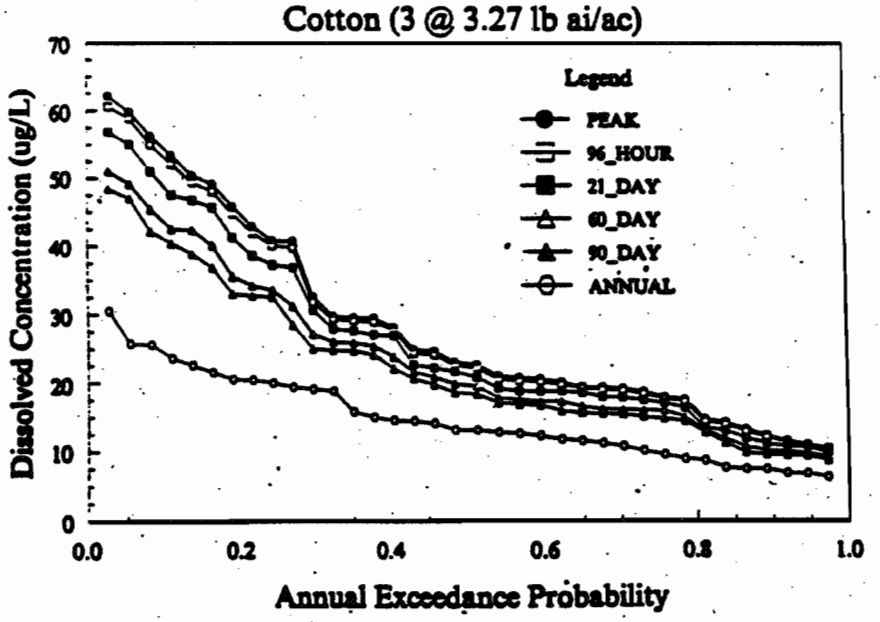

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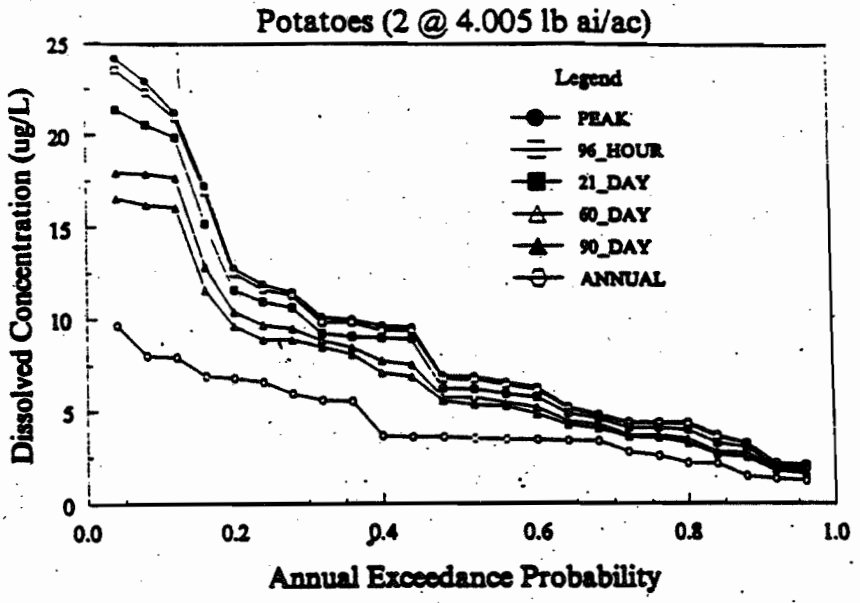

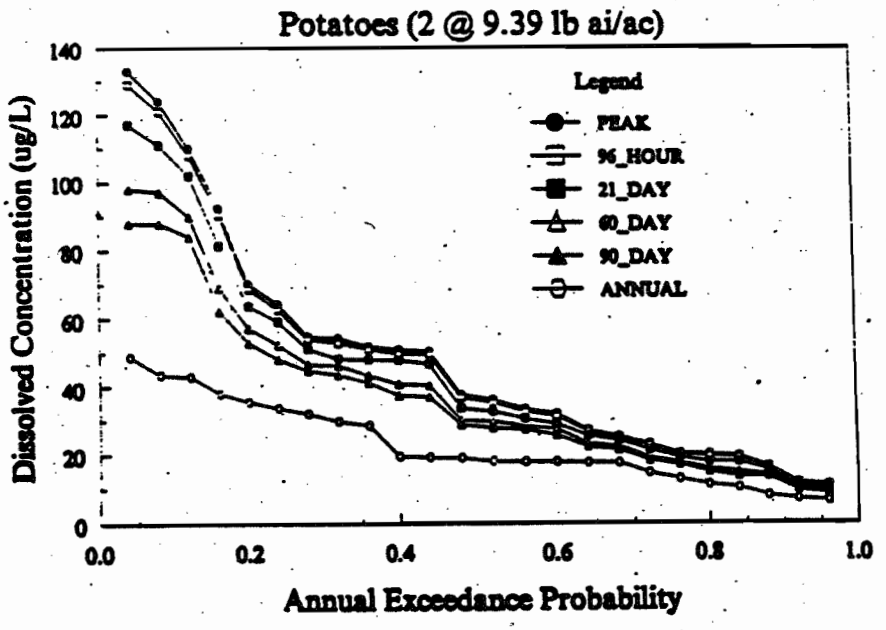

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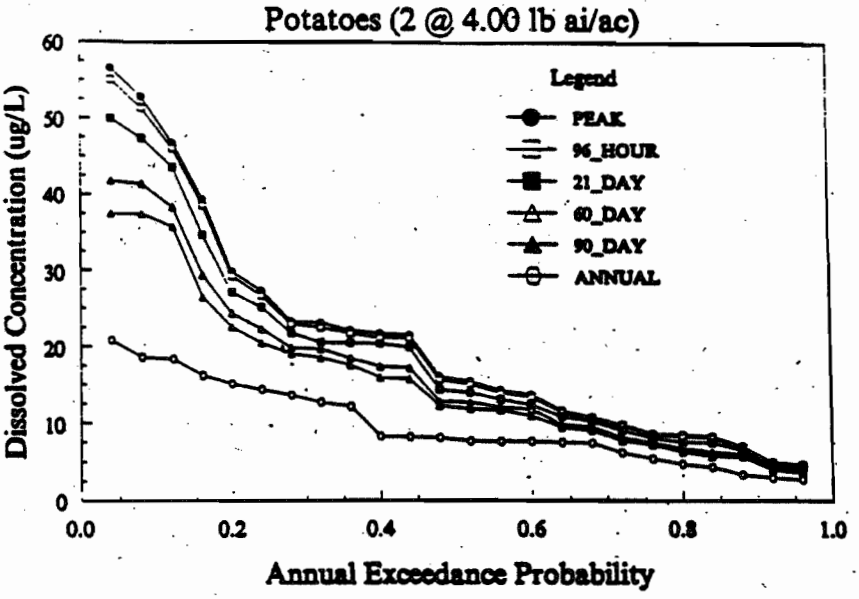

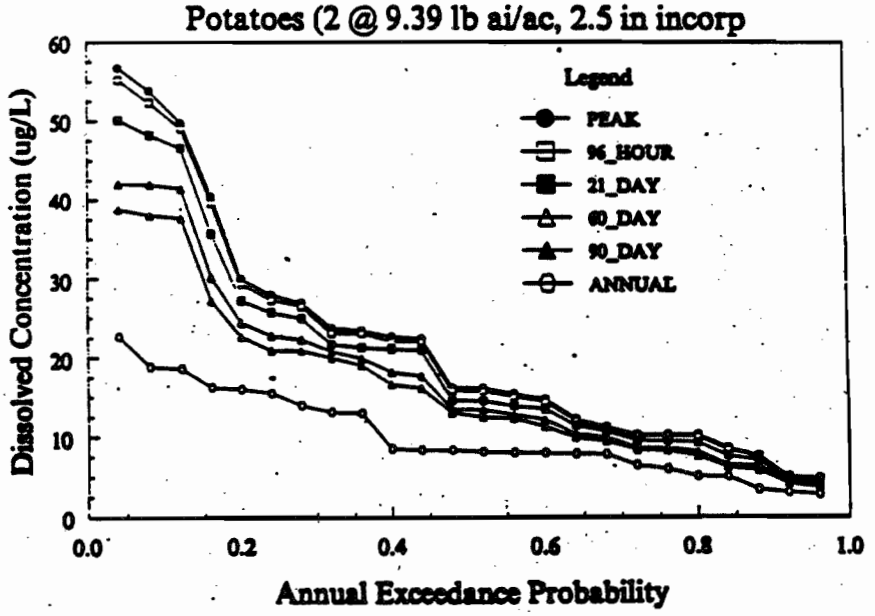

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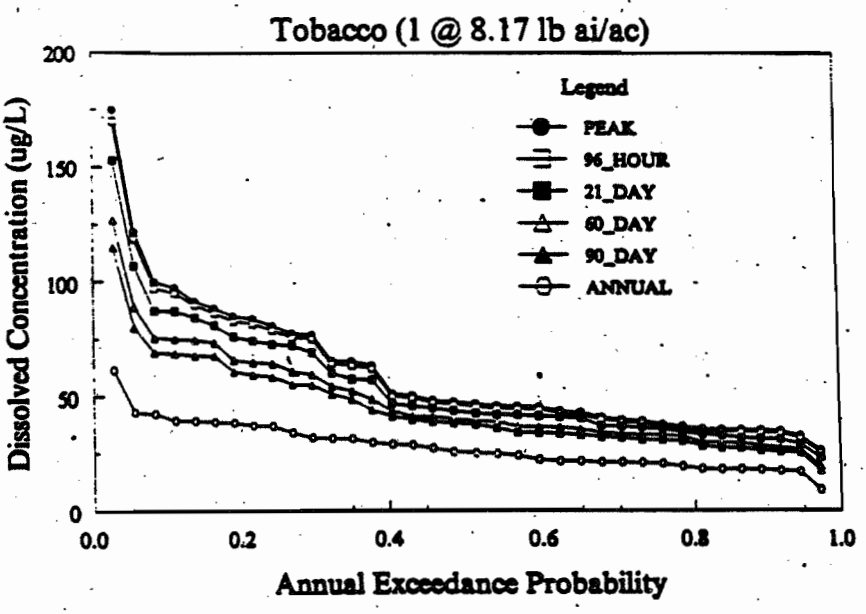

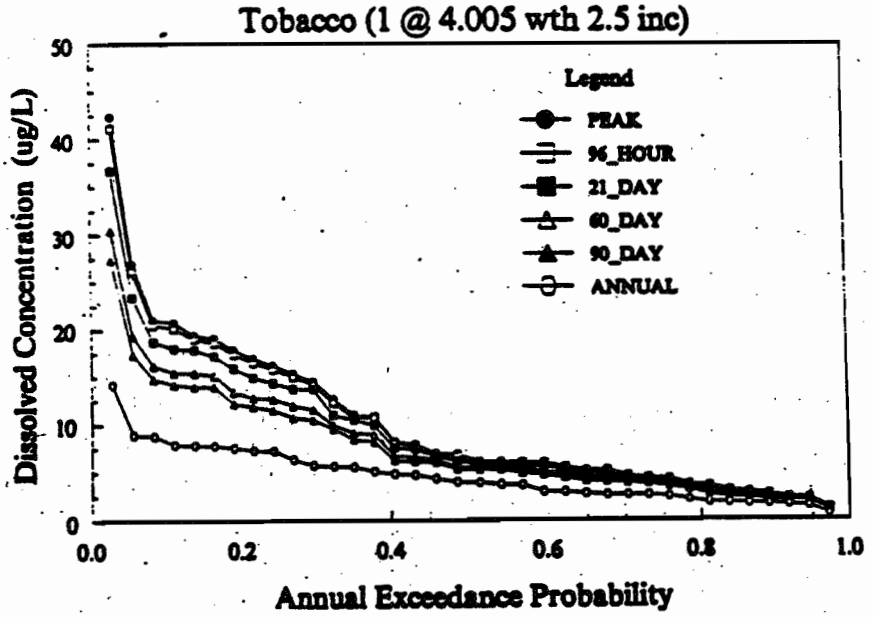

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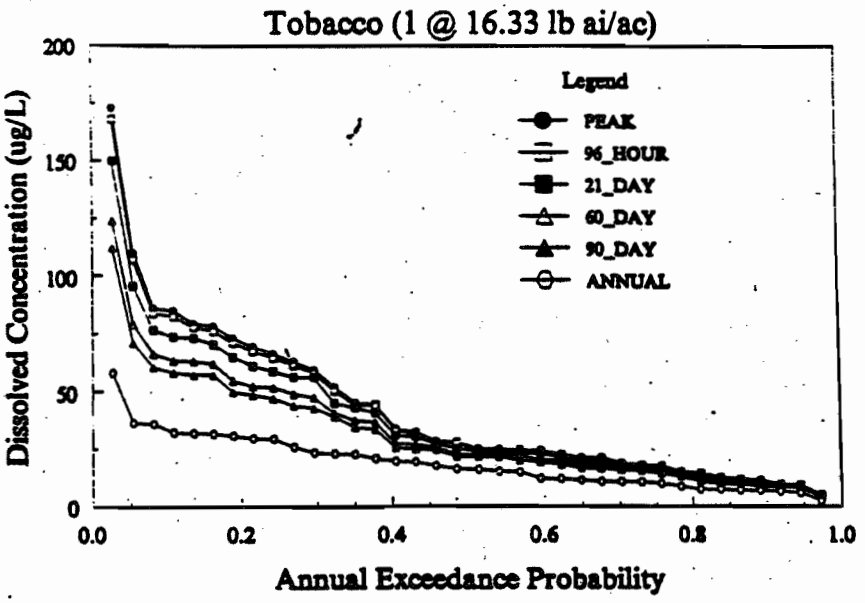

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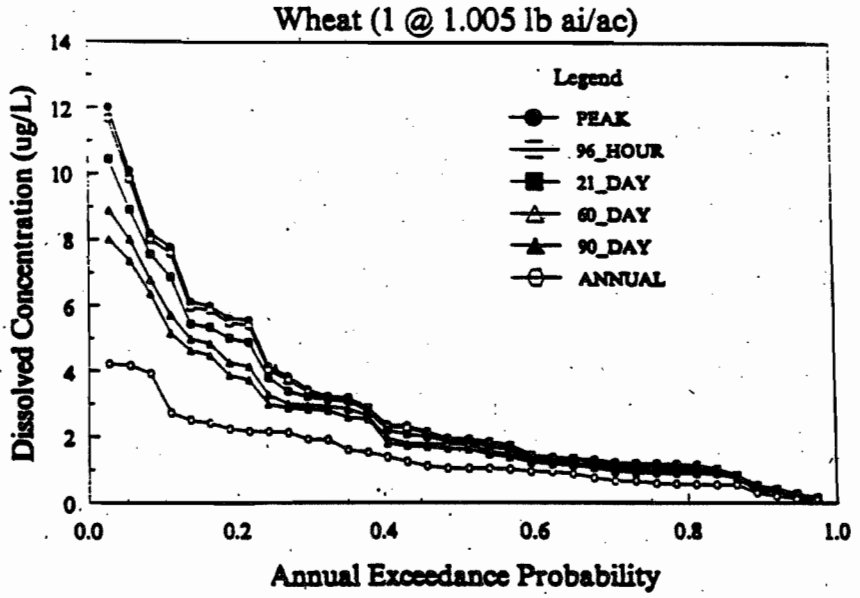

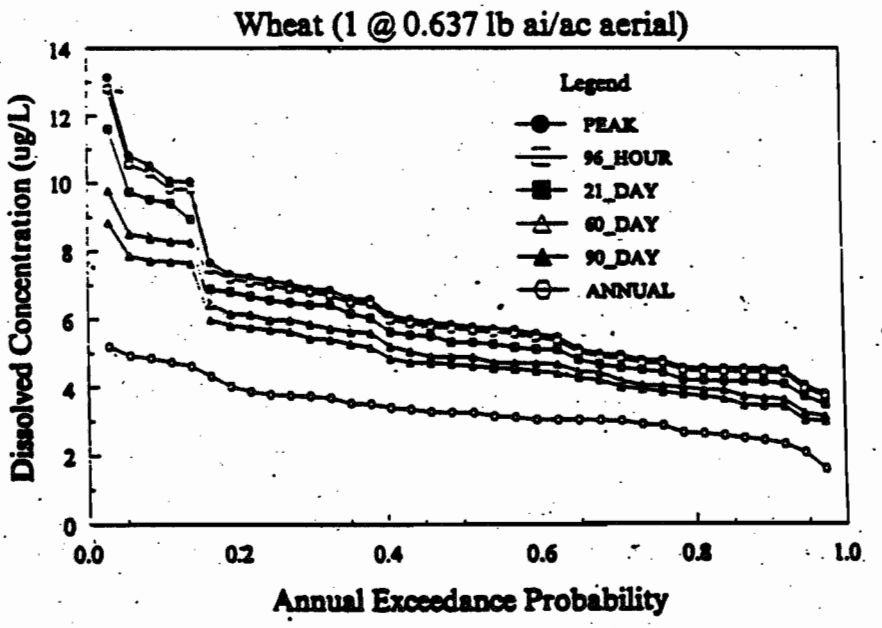

APPENDIX 6
Part 2
Draft Drinking Water Assessment for Disulfoton: Water Resources Assessment

D. Water Resources Assessment

i. Summary and Conclusions

This section presents an assessment of the potential to contaminate ground water and surface water from labeled uses of disulfoton. The assessment is a Tier II estimate of environmental concentrations (EECs) in surface water for disulfoton as applied to barley, cotton, potatoes, tobacco, and spring wheat, using several label application (maximum and recommended) rates and methods, using PRZM3/EXAMS2. Surface water monitoring data collected by the USGS as part of the National Water Quality Assessment (NAWQA) (Gilliom, 1995; USGS, 1997) program is also considered. The potential for disulfoton residues in ground water is assessed using the EFED ground-water concentration screening model (SCI-GROW) and the monitoring data available in EFED's Pesticides in Ground Water Data Base (PGWDB) (USEPA, 1992) and the NAWQA study (USGS, 1997). The purpose of this analysis is to estimate environmental concentrations of disulfoton in surface water bodies and ground water for use in the human health and ecological risk assessment as part of the registration process. The environmental fate data base is not complete. Limited data indicates that the degradates are much more persistent and mobile than parent disulfoton. The degradates, often as toxic as the parent compound, are not considered in this assessment due to lack of environmental fate data.

Tier I environmental concentrations (EECs) in surface water were also estimated, using the EFED screening model GENEEC, for disulfoton as applied to barley, cotton, potatoes, tobacco, and spring wheat, using several label application (maximum and recommended) rates and methods. These estimates were greater than those estimated by PRZM/EXAMS. Surface and ground water monitoring data available in STORET were evaluated, but not considered due to limitations associated with high detection limits and difficulty in interpreting the data. The results of these findings are presented in the Appendix II.

The Tier II EEC assessment uses a single site, or multiple single sites, which represents a high-end exposure scenario from pesticide use on a particular crop or non-crop use site. The EECs for disulfoton were generated for multiple crop scenarios using PRZM3.0 (Carsel, 1997) which simulates the erosion and run-off from an agricultural field and EXAMS 2.97.5 (Burns, 1997) which simulates the fate in a surface water body. PRZM3 and EXAMS estimates for a single site, over multiple years, EECs for a 1 ha surface area, 2 m deep pond draining an adjacent 10 ha barley, cotton, potato, tobacco, or spring wheat field. Each scenario, or site, was simulated for 27 to 40 (depending on data availability) years. EFED estimated 1 in 10 year maximum peak, 4-day average, 21-day average, 60-day average, 90-day, annual average concentrations. Disulfoton (Di-Syston) formulations were based upon registered uses on the specific crops. The application rates (maximum and recommended), numbers, and intervals are listed in **Table** 2 and environmental fate inputs are listed in **Table** 4. Spray drift is determined by method of pesticide application (5% for aerial spray; 1% for ground spray, 0% for granular or soil incorporated applications). The Tier II PRZM/EXAMS EECs for disulfoton are listed in a **Table** 2. PRZM

simulations were both made with the recommended and maximum application rates. maximum number of yearly applications. and the shortest recommended application interval.

The PRZM/EXAMS EECs are generated for high exposure agricultural scenarios and represent one in ten year EECs in a stagnant pond with no outlet that receives pesticide loading from an adjacent 100% cropped. 100% treated field. As such, the computer generated EECs represent conservative screening levels for ponds, lakes. and flowing water and should only be used for screening purposes. The EECs have been calculated so that in any given year. there is about a 10% probability that the maximum average concentration of that duration in that year will equal or exceed the EEC at the site. Tier II upper tenth percentile EECs are presented in **Table 2.**

The disulfoton scenarios **(Tables a and b)** are representative of high run-off sites for barley in the Southern Piedmont of Virginia (MLRA 136), cotton in the Southern Mississippi Valley Silty Uplands of Mississippi (MLRA 134), potatoes in the New England and Eastern New York Upland of Maine (MLRA 144A), tobacco in Southern Coastal Plain of Georgia (MLRA 133A), and spring wheat in the Rolling Till Prairie of South Dakota (MLRA 102A). The scenarios chosen are professional best judgement sites expected to produce run-off greater than would be expected at 90% of the sites where the appropriate crop is grown.

The SCI-GROW (Screening Concentration in Ground Water) screening model developed in EFED (Barrett. 1997) was used to estimate potential ground water concentrations for disulfoton parent under hydrologically vulnerable conditions. The maximum disulfoton ground water concentration predicted by the SCI-GROW using the maximum rate 9.39 lb. a.i./ac and 2 applications was 0.83 µg/L.

The fate of disulfoton in surface water and ground water and the likely concentrations cannot be modeled with a high degree of certainty, since no data are available for the aerobic and anaerobic aquatic degradation rates. and anaerobic soil metabolism. The large degree of latitude available in the disulfoton labels also allows for a wide range of possible application rates, total amounts. application methods, and intervals between applications. However, considering the relatively rapid rate of microbial degradation in the soil (<20 day aerobic soil metabolism half-life) and direct aquatic photolysis in (surface water, the disulfoton parent may degrade fairly rapidly (Howard. !991)). However, peak concentrations appear capable of being quite high, when high application rates used.

Ref.

Howard, P. H. (Ed.) 1991. Handbook of Environmental Exposure Data for Organic Chemicals. Vol. III. Lewis, Publishers. Chelsea, MI.

Limited ground water and surface water monitoring data available in the PGWDB (USEPA, 1992) and National Water-Quality Assessment (NAQWA) Program (USGS, 1997) tends to confirm fairly rapid degradation, as values measured values generally tend to be quite low. Although, no assessment can be made for degradates due to lack of data, limited data suggests

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that the degradates are more persistent (>200 days) than disulfoton, suggesting their presence in water for an longer period of time than the parent. The degradates also appear to be more mobile than the parent compound.

ii. Application Rates Used in Modeling

The application rates selected for use in the modeling scenarios were based upon information submitted by the registrant, analysis conducted by BEAD, and the disulfoton (Di-Syston) labels. Four factors went into selecting the application rate: 1) the range of ounces or pounds a.i.: 2) the area or length of row per acre (which is influenced by row spacing); 3) the number of applications; and 4) the application interval. The recommended and maximum rate (ounces or pounds a.i. per crop simulated) and the shortest application interval were selected. The shorter the distance between the crop rows the greater the application rate on an area basis. Two row spacing values were generally selected; one based on a near-the-maximum number of rows indicated by the label, and second based on the row spacing given in the label example (e.g., tobacco, page 8 of 14; 20 to 40 oz. per 1000 feet of row (for "any row spacing") or 13.3 to 26.7 lb. per acre or with a 48 inch row spacing). The label indicated that "any row spacing" could be as narrow as 6 inches. The narrowest row spacing used in this assessment was 12 inches. Thus a crop like tobacco had a range of application rates of 4.005 to 16.33 lb. a.i. per acre.

iii. Modeling Scenarios

Surface Water: The sites selected are currently used by EFED to represent a reasonable "at risk" soil for the region or regions being considered. The scenarios selected represent high-end exposure sites. The sites are selected so that they generate exposures larger than for most sites (about 90 percent) used for growing the selected crops. An "at risk" soil is one that has a high potential for run-off and soil erosion. Thus, these scenarios are intended to produce conservative estimates of potential disulfoton concentrations in surface water. The crop, MLRA, state, site, and soil conditions for the scenarios considered are given in **Tables a and b.**

Table a . Crop, location, soil and hydrologic group for each modeling scenario.

Crop	MLRA[1]	State	Soil Series	Soil Texture	Hydrologic Group	Period (Years)
Barley	136	VA	Gaston	sandy clay loam	C	27
Cotton	134	MS	Loring	silt loam	C	36
Potatoes	144A	ME	Paxton	sandy loam	C	36
Tobacco	133A	GA	Emporia	loamy sand	C	36
Spr.Wheat	102A	SD	Peever	clay loam	C	40

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'MLRA is major land resource area (USDA, 1981).

Table b. Selected soil properties used modeling.

Soil Series (MLRA)	Depth(in)	Bulk Density	Organic Carbon	Field Capacity	Wilting Point
Gaston (136)	16	1.6	1.740	0.246	0.126
	84	1.6	0.174	0.321	0.201
	50	1.6	0.116	0.222	0.122
Loring (134)	10	1.6	1.160	0.294	0.094
	10	1.6	1.160	0.294	0.094
	105	1.8	0.174	0.147	0.087
Paxton (144A)	20	1.6	2.90	0.166	0.66
	46	1.8	0.174	0.118	0.38
	34	1.8	0.116	0.085	0.035
Emporia (133A)	38	1.4	1.16	0.104	0.054
	62	1.6	0.174	0.225	0.125
	50	1.6	0.116	0.135	0.056
Peever (102A)	18	1.35	1.740	0.392	0.202
	82	1.60	0.116	0.257	0.177
	50	1.60	0.058	0.256	0.176

Ground Water: The SCI-GROW (Screening Concentration in Ground Water) screening model developed in EFED (Barrett, 1997) was used to estimate potential ground water concentrations for disulfoton parent under "generic" hydrologically vulnerable conditions. The SCI-GROW model is a model for estimating concentrations of pesticides in ground water under "worst case" conditions. SCI-GROW provides a screening concentration; an estimate of likely ground water concentrations if the pesticide is used at the maximum allowed label rate in areas with ground water exceptionally vulnerable to contamination. In most cases, a majority of the use area will have ground water that is less vulnerable to contamination than the areas used to derive the SCI-GROW estimate.

The SCI-GROW model is based on scaled ground water concentrations from ground water monitoring studies, environmental fate properties (aerobic soil half-lives and organic carbon partitioning coefficients-Koc's) and application rates.

iv. Modeling Procedure

Environmental fate parameters used in PRZM3 and EXAMS modelings are summarized in **Table __** . The standard pond (mspond) was used. The PRZM3 simulations were run for a period of 36 years on cotton, potatoes, and tobacco, beginning on January 1, 1948 and ending on December 31, 1983. Barley was run for 27 years (1956-1983) and spring wheat was run for 40 years (1944-1983). Scenario information is summarized in **Table a and b.** The EXAMS loading (P2E-C1) files, a PRZM3 output, were pre-processed using the EXAMSBAT post-processor. EXAMS was run for the 27-40 years using Mode 3 (defines environmental and chemical pulse time steps). For each year simulated, the annual maximum peak, 96-hour, 21-day, 60-day, 90-day values, and the annual means were extracted from the EXAMS output file REPORT.XMS with the TABLE20 post-processor. The 10 year return EECs (or 10% yearly exceedance EECs) listed in **Table** 2 were calculated by linear interpolation between the third and fourth largest values by the program TABLE20. Cumulative frequency plots for each scenario are provided in Appendix II.

v. Modeling Results

a. Surface water

In the Tier II assessment, the 90th percentile of the estimated multiple year mean concentrations of disulfoton in a farm pond over multiple years simulated ranged from 3.08 µg/L for a single maximum application (@1.00 lb ai/a) to spring wheat in South Dakota to 43.24 µg/L for potatoes in Maine with the two applications at the maximum application rate (@9.39 lb ai/ac). Maximum, or peak, estimated concentrations of 117.0 µg/L occurred for two 9.39 lb. ai/ac applications of disulfoton to potatoes. For the other scenarios or recommended application rates, the maximum concentrations ranged from 7.72 to 98.19 µg/L. Because of limited data, the modeling results therefore cannot be confirmed by the monitoring data.

Table . 2 Tier II Upper Tenth Percentile EECs for Disulfoton Used on barley, cotton, potatoes, tobacco, and spring wheat for several application (recommended and maximum) rates and management scenarios estimated using PRZM3/EXAMs.

Crop	Disulfoton Application Rate/Number/Interval/Incorp. Depth lb.ai../ac/ #/ days/ inches	Concentration (µg/L) (1-in-10 annual yearly maximum value) Peak	96-Hour Avg.	21-Day Avg.	60-Day Avg.	90-Day Avg.	Annual Avg.
Barley[1]	1.00/2/21/0	17.92	17.48	15.85	13.95	12.59	7.12
Barley	0.83/2/21/0 (aerial)	18.02	17.62	16.50	14.75	13.56	7.75
Cotton[1]	1.01/3/21/2.5	16.75	16.35	14.98	13.39	12.63	7.47
Cotton	3.27/3/21/2.5	54.24	52.97	48.54	43.35	40.91	24.20
Potatoes[1]	4.01/2/14/2.5	22.08	21.62	20.21	17.78	16.13	7.98
Potatoes	9.39/2/14/0	117.00	114.50	106.50	93.54	85.92	43.24
Potatoes[1]	4.00/2/14/0	49.76	48.69	45.44	39.84	36.59	18.42
Potatoes	9.39/2/14/2.5	51.78	50.69	47.39	41.69	37.83	18.71
Tobacco	8.17/1/0/2.5	98.19	95.71	87.30	75.11	68.75	40.33
Tobacco[1]	4.00/1/0/2.5	20.85	20.27	18.24	15.70	14.38	8.17
Tobacco	16.33/1/0/2.5	85.02	82.66	74.36	64.00	58.62	33.29
Spr.Wheat	1.00/1/0/0	7.90	7.72	7.08	6.03	5.51	3.08
Spr.Wheat	0.64/1/0/0 (aerial)	10.20	9.96	9.44	8.32	7.71	4.77

[1] Rate recommended on label.

The PRZM/EXAMs estimated disulfoton residue concentrations in surface water appear to be strongly related to application rate, number of applications, application interval, and method of application.

b. Ground water

The maximum disulfoton ground water concentration predicted by the SCI-GROW model (based on 2 maximum (e.g., potatoes) applications at 9.39 lb. a.i./ac) was 0.83 µg/L.

vi. Disulfoton Monitoring Data

The Pesticides in Ground Water Data Base (USEPA. 1992) summarizes the results of a number of ground water monitoring studies conducted which included disulfoton (and disulfoton degradates D. sulfone and D. sulfoxide). Monitoring. with no detections (limits of detections ranged from 0.01 to 6.0 µg/L). have occurred in the follow states (number of wells): AL (10). CA (974). GA (76). HI (5). IN (161). ME (71). MS (120). MN (754). OK (1). OR (70). and TX (188). Disulfoton residues were detected in ground water in Virginia and Wisconsin. In Virginia. 6 of the 12 wells sampled had disulfoton detections ranging from 0.04 to 2.87 µg/L. In Wisconsin. 14 of 26 wells sampled had disulfoton residues ranging from 4.0 to 100.0 µg/L. The Wisconsin study could not be located to determine the source of the high value found. One hundred twenty wells were analyzed in MS for degradates D. sulfone and D. sulfoxide and 188 wells were analyzed in TX for D. sulfone. Limits of detection were 3.80 and 1.90 µg/L for the sulfone and sulfoxide degrade, respectively, in MS. There were no degradates reported in these samples. Disulfoton residues were found in 10 (0.37%) out of 2700 surface water samples collected by the USGS in the NAWQA (USGS, 1997) and are summarized in Table **xx.** Concentrations ranged from 0.02 to 0.041 µg/L with a minimum detection limit (MDL) of 0.017µg/L. There were no detections reported in ground water in about 2200 ground-water samples.

Table 3. Summary of Detections in USGS NAQWA Study (USGS, 1997[1]).

Water Source	%> 0.01 µg/L	Maximum Concentration
Agricultural Streams	0.2	0.041
Urban Streams	0.0	0.007
Integrated Streams	0.0	0.002
Agricultural Wells	0.0	0.002
Urban Wells	0.0	None
Major Aquifers	0.0	None

[1] USGS, 1997 NAQWA, (URL http://water.wr.usgs.gov/pnsp/gwswl.html, August 1997)

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USGS. 1997. Pesticides in Surface and Ground Water of the United States: Preliminary

Results of the National Water Quality Assessment Program(NAWQA) August, 1997. Pesticides National Synthesis Project, National Water-Quality Assessment, U.S. Geological Survey

Several limitations for the monitoring data should be noted. These limitations include: the use of different limit of detections between studies, lack of information concerning disulfoton use around sampling sites, and lack of data concerning the hydrogeology of the study sites.

vii. Limitations of this Modeling Analysis

There are several factors which limit the accuracy and precision of this modeling analysis including the selection of the high-end exposure scenarios, the quality of the data, the ability of the model to represent the real world, and the number of years that were modeled. There are additional limitations on the use of these numbers as an estimate of drinking water exposure. Degradation/metabolism products were also not considered due to lack of data. Another major limitation in the current EXAMS simulations is that the aquatic (microbial) degradation pathway was not considered due to lack of data. Direct aquatic photolysis was however included.

Spray drift is determined by method of pesticide application: 0% percent when applied as broadcast (granular) or in-furrow, 1% for ground spray, and 5% for aerial spray.

Tier II scenarios are also ones that are likely to produce high concentrations in aquatic environments. The scenarios were intended to represent sites that actually exist and are likely to be treated with a pesticide. These sites should be extreme enough to provide a conservative estimates of the EEC, but not so extreme that the model cannot properly simulate the fate and transport processes at the site. The EECs in this analysis are accurate only to the extent that the sites represent the hypothetical high exposure sites. The most limiting aspect of the site selection is the use of the "standard pond" which has no outlet. It also should be noted that the standard pond scenario used here would be expected to generate higher EECs than most water bodies; although, some water bodies would likely have higher concentrations (e.g., a shallow water bodies near agriculture fields that receive direct run-off from the treated field).

The quality of the analysis is also directly related to the quality of the chemical and fate parameters available for disulfoton. Acceptable data are available, but rather limited. Data were not available for degradates and the aquatic aerobic metabolism rate was not known, but estimated. The measured aerobic soil metabolism data is limited, but has sufficient sample size to establish an upper 90% confidence bound on the mean of half-lives for the three aerobic soils tested in the laboratory (and submittted to EFED) and reported in the EFED One-liner Database (MRIDs 40042201, 41585101, 43800101). The use of the 90%-upper bound value may be sufficient to capture the probable estimated environmental concentration when limited data are available.

The models themselves represent a limitation on the analysis quality. These models were not specifically developed to estimate environmental exposure in drinking water so they may have limitations in their ability to estimate drinking water concentrations. Aerial spray drift reaching the pond is assumed to be 5 percent of the application rate and for ground spray it is 1 percent of the application rate. No drift was assumed for broadcast or in-furrow applications. Another limitation is the lack of field data to validate the predicted pesticide run-off.. Although, several of the algorithms (volume of run-off water, eroded sediment mass) are somewhat validated and understood, the estimates of pesticide transport by PRZM3 has not yet been fully validated Other limitations of the models are the inability to handle within site variation (spatial variability), crop growth, and the overly simple soil water balance. Another limitation is that 27 to 40 years of weather data was available for the analysis. Consequently there is a 1 in 27, 36, or 40 chance that the true 10% exceedance EECs are larger than the maximum EEC in the analysis. If the number of years of weather data were increased, it would increase the level of confidence that the estimated value for the 10% exceedance EEC was close to the true value.

EXAMS is primarily limited because it is a steady-state model and cannot accurately characterize the dynamic nature of water flow. A model with dynamic hydrology would more accurately reflect concentration changes due pond overflow and evaporation. Thus, the estimates derived from the current model simulates a pond having no-outlets, flowing water, or turnover. Another major limitation in the current EXAMs simulations is that the aquatic (microbial) degradation pathway was not considered due to lack of data. Direct aquatic photolysis was however included.

Another important limitation of the Tier II EECs for drinking water exposure estimates is the use of a single 10 hectare drainage basin with a 1 hectare pond. It is unlikely that this small system accurately represents the dynamics in a watershed large enough to support a drinking water utility. It is unlikely that an entire basin, with an adequate size to support a drinking water utility would be planted completely in a single crop or be represented by scenario being modeled. The pesticides would more likely be applied over several days to weeks rather than on a single day. This would reduce the magnitude of the conservative concentration peaks, but also make them broader, reducing the acute exposure, but perhaps increasing the chronic exposure.

Monitoring data is limited by the lack of correlation between sampling date and the use patterns of the pesticide within the study's drainage basin. Additionally, the sample locations were not associated with actual drinking water intakes for surface water nor were the monitored wells associated with known ground water drinking water sources. Also, due to many different analytical detection limits, no specified detection limits, or extremely high detection limits, a detailed interpretation of the monitoring data is not always possible.

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